OLUME 52 NUMBER 1 . . . . ONE YEAR FOUR DOLLARS

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GENERAL ELECTRIC REVIEW

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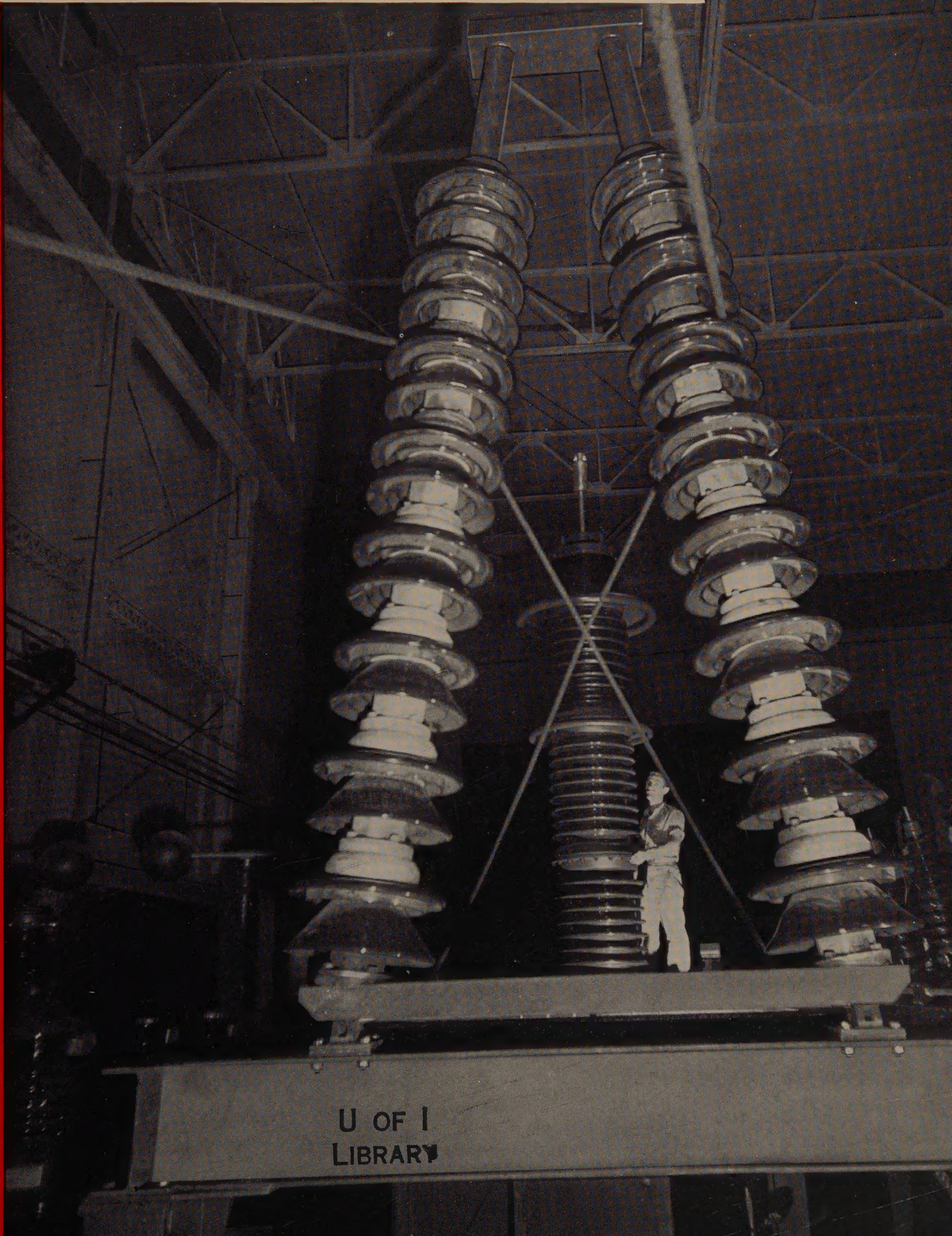
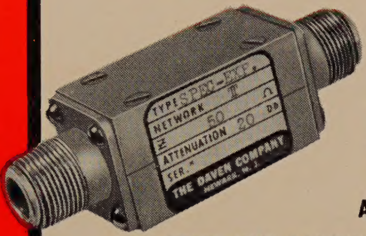


NUARY
1949

NEW!... R. F. AND VIDEO COMPONENTS FOR PRECISE CONTROL

In keeping with the Daven policy of continually developing new components to meet the electronic industry's new needs, we are once again first to offer video and radio frequency fixed and variable attenuators. These units embody the characteristics which have come to be synonymous with the name DAVEN . . . excellence of workmanship, top-notch design, finest materials and accurate, efficient performance.

R. F. FIXED ATTENUATORS



TYPE RF-155

CIRCUIT: π network.

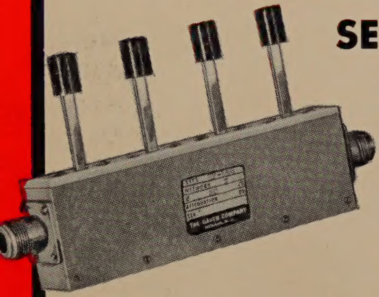
IMPEDANCE: 50 ohms.

LOSS: 5 to 20 DB.

ACCURACY: ± 2% at D.C.

IMPEDANCE ACCURACY: Same as series RF-540

R. F. VARIABLE ATTENUATORS



SERIES RF-540

CIRCUIT: π network.

IMPEDANCE: 50 ohms.

NO. OF STEPS: 4 (push-buttons.)

RESISTOR ACCURACY: ± 2% at D.C.

IMPEDANCE ACCURACY: Terminal impedance of loss network essentially flat from 0-225 MC.

LOSS:

Type RF-540—1, 2, 3, 4 DB (10 DB total.)

Type RF-541—10, 20, 20, 20 DB (70 DB total.)

Type RF-542—2, 4, 6, 8 DB (20 DB total.)

Type RF-543—20, 20, 20, 20 DB (80 DB total.)

SUGGESTED APPLICATIONS

- In signal generators.
- In field strength measuring equipment.
- Nucleonic and atomic research.
- Television receiver testing.
- Wide-band amplifiers.
- Pulse amplifiers.
- Any application where attenuation of UHF is required.

Patent applied for.

VIDEO FIXED ATTENUATORS

TYPE V-154

CIRCUIT: "T" network or equivalent.

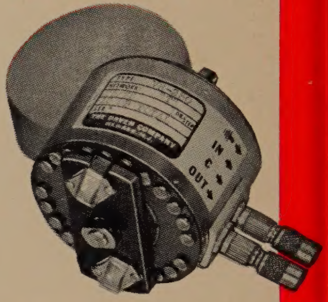
IMPEDANCE: 75 ohms.

LOSS: 1 to 20 DB.

ACCURACY: ± 1% at D.C.

FREQUENCY CHARACTERISTICS: Essentially flat to 10 MC.

VIDEO VARIABLE ATTENUATORS



SERIES V-250

CIRCUIT: "T" network.

IMPEDANCE: 75 ohms.

RESISTOR ACCURACY: ± 1% at D.C.

FREQUENCY CHARACTERISTICS: Essentially flat to 10 MC.

TYPE	NO. OF STEPS	DB PER STEP	TOTAL DB
V-250	10	1	10
V-251	10	2	20
V-252	20	1	20
V-253	20	2	40

These units will be supplied with co-axial connectors or regular terminal boards with lugs.

NOTE: *A video push-button control, similar to the R.F. push-button unit shown, is available.* ***Additional information will be furnished on request.***

SUGGESTED APPLICATIONS

- In television video circuits where a wide frequency range without change of impedance is of special importance.
- Wide-band amplifiers.
- Pulse amplifiers.

THE DAVEN CO.
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

ELECTRICAL AND ALLIED DEVELOPMENTS DURING 1948

By GUY BARTLETT

General Electric Company, Schenectady, N. Y.

Guy Bartlett

MOST outstanding of the engineering developments and trends of the electrical industry during 1948 were those in the field of power roduction—in the development of new and more fficient apparatus, and in investigations leading to etter understanding of the fundamentals of high-emperature and high-stress metallurgy.

Atomic power springs first to mind. A new reactor, ecidedly different from the production reactors at Ianford (Wash.), will be constructed at a new site a ew miles from the Knolls Atomic Power Laboratory t Schenectady, it was announced by the Atomic nergy Commission. Its purpose is peaceful—to study he generation of electric power from nuclear energy.

Only slightly, if any, less in public interest has been he gas turbine. Late in the year America saw its first as-turbine-driven locomotive on the tracks, undergoing service tests after successful completion of more han 700 hr of factory operation of the power plant. his oil-fired 4800-hp turbine is of in-line design, particlarly suitable for locomotive application (FIG. 1).

Construction was in progress on several gas-turbine ower plants for power generation, some of 3500-kw nd others of 5000-kw capacity. Two will use natural as as the fuel, the others fuel oil. These units will be ore complex than the locomotive units, so that their el economy will be competitive with steam plants of omparable size. Engineers say this is only the beginning -that the gas turbine promises rapid and impressive dvances in efficiency.

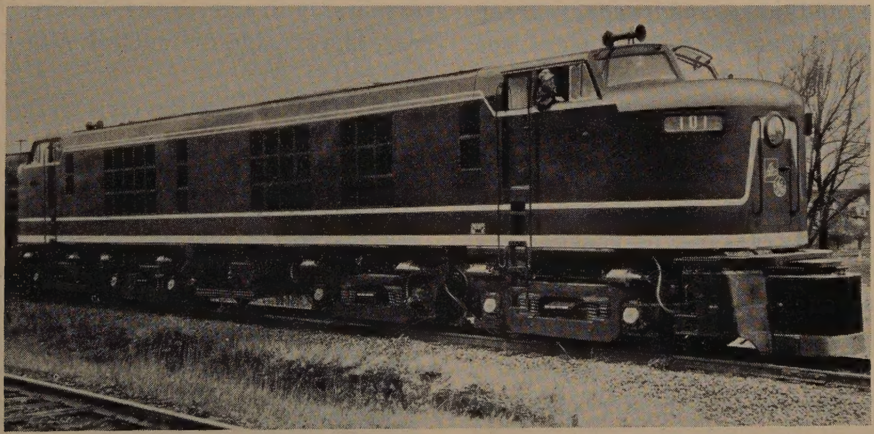


Fig. 1. A railroad gas-turbine power plant was installed for testing in an Alco-G.E. locomotive

A metallurgy program aimed at a fuller understandg of the behavior of metals at very high temperatures will eventually make possible improved alloys for gas turbines, turbo-jets, and other industrial applications. This objective is significant in the development of power sources of the future.

Also of import in the field of power generation was the Research Laboratory announcement that a new aluminum alloy has $2\frac{1}{2}$ times the elastic strength and only 1/10th the true creep rate of "electrical conductivity" (or E. C.) grade of aluminum, and at the same time has satisfactory conductivity. A trace of magnesium makes the difference. It is expected to permit further development of large generators and also to serve as a generally useful replacement for hard-to-get copper.

Krypton, one of the rare and inert gases present in the atmosphere to the extent of one part in a million, was given a job to do in fluorescent lamps. Replacing argon which is far more common—nearly one part in a hundred in the air—this gas is used in a new fluorescent lamp of the same high light output, long life, and outside dimensions as the older 100-watt lamp, but uses only 85 watts.

The list of engineering advances of the year has many other interesting examples in a wide variety of fields. There is, for instance, the use of magnetic suspension, whereby a watthour meter's rotating disk and shaft are suspended in space by the interaction of two tiny but powerful permanent magnets.

Only the developments—electrical, mechanical, chemical—of General Electric and its affiliated manufacturing companies are included in the following pages, but the report indicates design and construction trends of the electrical industry as a whole.

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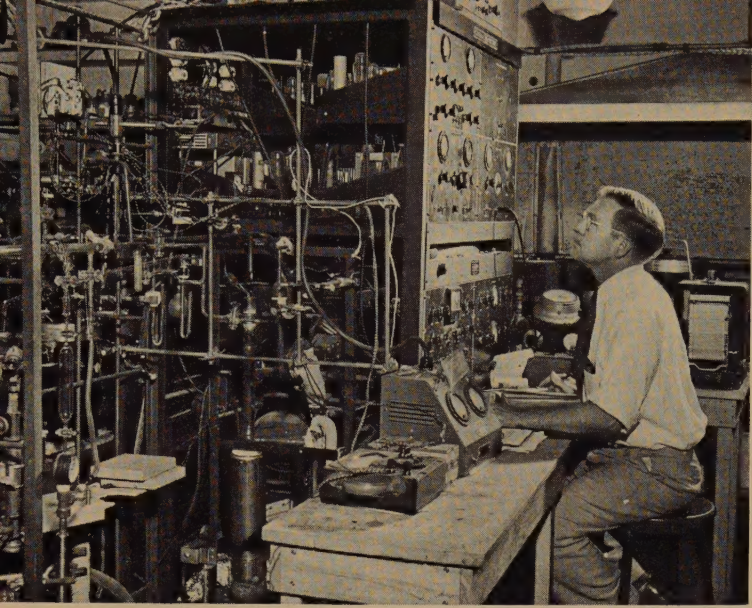


The mass spectrometer, comprising a complex assemblage of electronic, chemical, and measuring devices, has a wide variety of applications in research and process control

RESEARCH

• • • • • • • •

Atomic Power . . . *New Reactor*

PLUTONIUM—valuable man-made element whose destiny is either atomic bombs or atomic-energy fuel—was produced through the year at Hanford Works, in the State of Washington.

Across the continent—at the Knolls Atomic Power Laboratory on the outskirts of Schenectady—scientists went forward toward harnessing this element for world benefit as a power producer.

The original Hanford Works, now operated by the General Electric Company for the United States Atomic Energy Commission, cost some $350,000,000. Modernization, plant additions, and residential construction at a cost greater than the original plant were underway during the year.

The Atomic Energy Commission announced in September that it was acquiring 4500 acres of land in Saratoga County, about 18 miles north of the Knolls Atomic Power Laboratory, as the site of an experimental atomic power plant for studying generation of electric power from nuclear energy. It will be part of the Knolls laboratory operated by General Electric.

This new Knolls reactor will be decidedly different from the production reactors at Hanford. It is one of two being designed especially for studying high-temperature operation and the production of power. A different type reactor, but for a similar purpose, is planned at the Argonne National Laboratory near Chicago. Both are designed to work on the problem of power generation by nuclear fission, but by different methods; both are expected to yield important data leading ultimately to the design of reactors to produce power on a practical scale. They will be valuable also in solving problems involved in "breeding" nuclear fuel.

If the breeding process works as scientists have reason to expect, the reactor will more than replenish the fuel consumed in operation. In addition to producing heat, a breeder-type reactor would convert nonfissionable uranium-238 into new fissionable matter.

Nuclear Tools . . . *300,000,000 Volts*

A new type synchrotron, under construction in the Research Laboratory, will operate initially at 300,000,000 electron volts. It is being sponsored by the Office of Naval Research. Chief among the radical innovations in its design is the elimination of iron from the magnetic circuit. As in the previously made 70-Mev synchrotron, the acceleration cycle will involve a betatron phase, and a synchrotron phase after the electrons have nearly attained the speed of light. In iron-core machines, the desired field distribution is obtained by appropriately shaping the pole pieces; in the new air-core equipment, this is done by the positioning of the field coils and the choice of field currents. With devices capable of penetrating the atomic nucleus, it is hoped that more extended controlled experiments can be performed in the laboratory involving reactions similar to those known to occur in cosmic rays.

A 50,000,000-volt biased betatron (FIG. 2) producing high-energy x-rays is expected to have value in cancer research. It weighs about eight tons and is a compact version of the 135-ton betatron operated at 100,000,000 volts in the laboratory for several years in atomic research. A machine of the 50,000,000-volt size can be so mounted on trunnions that the beam can be directed toward a patient at any desired angle. The new betatron will be used in a program conducted by the biology department of Union College at Schenectady, with the support of the Atomic Energy Commission, studying the effects of high-energy radiation on living organisms. A 70,000,000-volt synchrotron, comparable in size to the 50,000,000-volt biased betatron, is available for nuclear research and therapeutic studies (p. 14).

At Pittsfield, exciting coils were made for a synchrocyclotron rated at more than 100,000,000 electron volts.

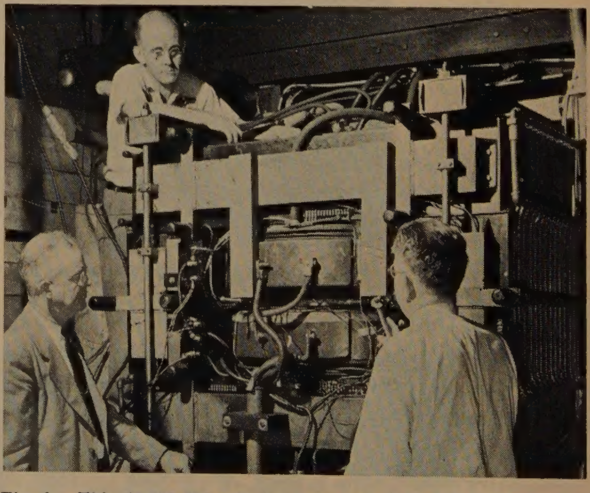


Fig. 2. This 50,000,000-volt betatron for medical use weighs only eight tons

Each of the two coils weighs about 38 tons, and has a 14-ft diameter.

Microwave Spectroscopy . . . *Radar Preceded It*

Microwave technology of the war's radar program has presented the spectroscopist with a powerful new tool for studying molecular structure. Molecular absorption is the most accurate method of determining dimensions of molecules—x-ray diffraction and electron diffraction are the other methods—but it was limited by the resolving power attainable with infrared absorption methods. Electronic techniques in the microwave region (FIG. 3) have increased the resolving power several hundredfold. Source of the microwave power is a tunable klystron, generating a band of frequencies around 24,000 megacycles. The power is fed into a 16-ft wave-guide which serves as an absorption cell for the gas under investigation. Molecular dimensions are determined from a single experimental determination, the measurement of the frequency of the absorption lines.

Single-sideband Transmission . . *Something New in Radio*

Transmission of signals by means of single sideband instead of by two sidebands, as in conventional broadcasting, possesses several advantages such as economy of power, dual transmission, and reduced distortion. A system developed in the Research Laboratory uses phase-shift networks that are relatively simple and inexpensive in comparison with previous elaborate filter circuits. Commercial announcement of equipment has been made (p. 42).

Metallurgy . . . *New Conductor*

Best commercial aluminum ("electrical conductivity" or E.C. grade) has a minimum of 99.45 percent aluminum, the chief impurities being 0.25 to 0.45 percent iron and about 0.10 percent silicon. Improvement of elastic and creep strengths of this aluminum was greatly desired. It was found that the addition of a slight amount of magnesium to the E.C. grade gives satisfactory conductivity, an elastic strength 250 percent higher, and a true creep rate (under the same stress) only 1/10 that of E.C. grade (at operating temperatures). Furthermore, the new composition is actually strengthened by heating in the range of generator operating temperatures, whereas many alloys slowly soften at such temperatures. The new conductor permits further development of large generators, and also promises a generally useful replacement for scarce copper.

A new method of coating metals with metal powders consists of spreading a layer of powder of the thickness desired on the metal surface, such as iron chromium or stainless steel, and then heating in hydrogen atmosphere a short time at below the eutectic temperature.

It was found that an alloy of 80–20 nickel-tungsten has identical structure but different mechanical and physical properties according to how it was aged—whether quenched and aged at 950 C, or at 925 C or lower. Further work along this line is expected to help in explaining the behavior of high-temperature alloys.

Large single crystals of metals, such as copper, can be fabricated in a half hour by a new laboratory method. Thus, experimental programs requiring single crystals are much more feasible.

New theories have made it possible to calculate the rate of formation of new phases during the heat treatment of steel, and thus to predict quantitatively the effects of alloying elements on the rates of reactions. Proper alloying elements for various heat-treatment cycles required for producing desired properties in steels can be determined.

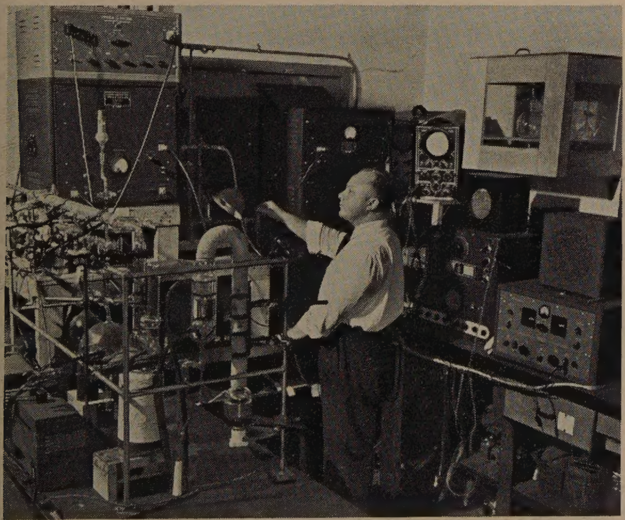


Fig. 3. The microwave spectroscope—powerful new tool for studying molecular structure

A tube used in studying the speed of electrons knocked loose from an element by ultraviolet radiation

The eutectic alloy of 11 percent phosphorus, 89 percent nickel, melts at 880 C, and in a hydrogen atmosphere flows freely at temperatures less than 1000 C. In the liquid state, the solder has high surface tension, and spreads and forms small fillets along crevices or inside corners. It is more resistant to attack by mercury or alkaline-earth metals than are silver- or copper-base solders. The Ni-P alloy is hard and brittle, however, and cannot be used where strength of joint is dependent on the solder alone.

Surface-conducting Glass . . . *High Resistances*

A conducting coating was developed for application to porcelain surfaces. A special glass, containing considerable lead oxide, is powdered, sprayed, and fired on the porcelain. Conductivity is developed by reducing the lead oxide to lead in a hydrogen furnace. Immediately after hydrogen treatment the resistance is commonly 2000 megohms per square. (Since thickness is uniform, the resistance of any square area is the same regardless of the size of the square.) The coating is suitable for use on inner walls of vacuum tubes, or on surfaces in Freon. The resistance gradually increases when exposed to the atmosphere, especially at high relative humidity and high voltage gradients.

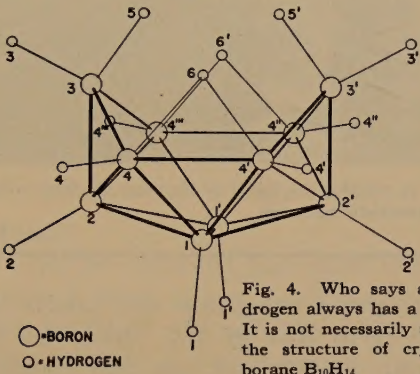


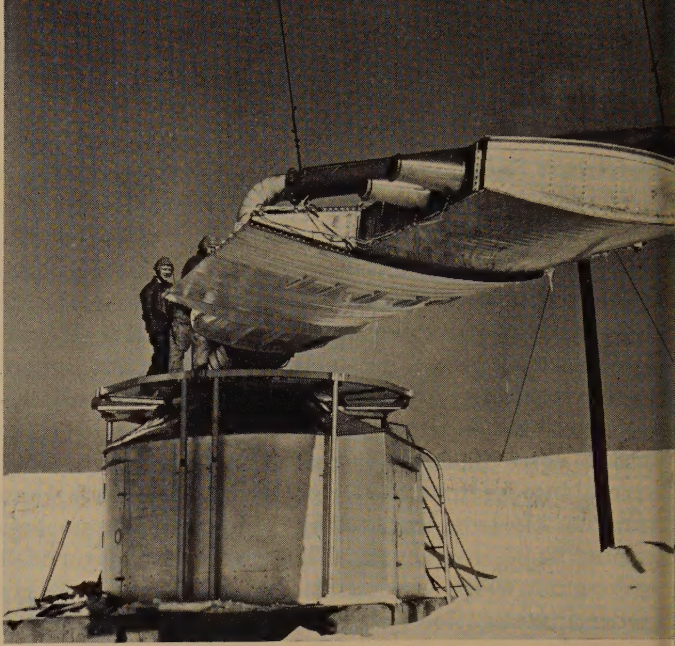
Fig. 4. Who says an atom of hydrogen always has a valence of one? It is not necessarily so, as shown by the structure of crystallized decaborane $B_{10}H_{14}$

Boron Hydride . . . *Quite a Structure*

Chemists were particularly interested in the announcement that the atomic arrangement in crystallized decaborane $B_{10}H_{14}$ had been determined. The molecules have a structure (Fig. 4) quite different from any that could have been predicted on the basis of previous chemical theories. Before the structure could be determined, it was necessary to develop new methods of finding atomic arrangement.

Weather . . . *Doing Something About It*

There have been numerous headlines since the first announcement two years ago that scientists had created snowfall by seeding clouds with carbon dioxide crystals. During the year it was announced that silver iodide smoke generators, dispensing tiny silver iodide particles into the atmosphere, would produce snow or rain, depending on temperature and humidity near the ground. These smoke generators will be tested in actual weather conditions by the U.S. Army Signal Corps and the Office of Naval Research under the weather research program known as "Project Cirrus." The clearing of overcast, specifically at airports, is a main objective.



Typifying some of the unusual and specialized developments for modern testing requirements are the test facilities which have been provided for studying jet-propelled helicopters

TESTING AND MEASURING

• • • • • • • •

TESTING EQUIPMENTS

Helicopter Test . . . *Expanded Facilities*

FACILITIES for the development and testing of component parts for proposed jet-propelled helicopters were expanded substantially by the General Engineering and Consulting Laboratory. Adjacent to the large hangar at the Flight Test Center at the Schenectady County airport are the new facilities which include an outdoor bowl-shaped pit of 150-ft diameter and 13-ft depth, with a propelling mechanism for testing jet units located at the tip of the whirling helicopter blade. A nearby structure houses a laboratory and workshop, as well as control and instrument equipment. A special thick-walled observation room adjoins the pit.

Particle Accelerators . . . *Beta-, Synchro-, Cyclo-*

Among particle accelerators developed and produced during the year was a 10,000,000-volt betatron for industrial radiography at Naval Ordnance, White Oaks (Md.). Tests are underway on a completed 50,000,000-volt betatron for the National Bureau of Standards at Washington (D.C.) to be used in investigating high-energy rays.

A 70,000,000-volt synchrotron is being built for nuclear research at Queens University, Kingston (Ont.). Design work was carried on and manufacture of parts begun for a 60-in. cyclotron (Fig. 5) with a rating of 20,000,000-volt deuterons at 200 μa. It will be used or nuclear research, as will two 100,000,000-volt betarons that were in manufacture for the University of Chicago and the Oak Ridge National Laboratories, Oak Ridge (Tenn.).

ockets . . . *Ready to Launch*

The rocket research and development program onducted for the Army Ordnance Department by he Company's Aeronautic and Ordnance Systems Divisions with the Research Laboratory, General Engineering and Consulting Laboratory, Electronic Laboratory, and others co-operating continued through its hird year. In February, a German V-2 rocket was conrolled in flight for the first time. Development of elemetry equipment for use in rockets, where weight nd space are restricted, continued; present equipment weighs only 23 lb and transmits 28 different kinds of nformation every 1/30 sec. A new ground station or receiving the signals was completed. The first opporunity to evaluate many developments will be early in 949 when the first test vehicle designed by this group will be launched.

ELECTRICAL MEASUREMENTS

Watthour Meters . . . *Magnetic Suspension*

MAGNETIC suspension of the rotor or moving element is the outstanding feature of a single-phase watthour meter (Fig. 6) introduced during the year. Two concentric magnets of high-coercive cunico supply the suspension. The outer magnet is attached to the frame; he inner one is an integral part of the disk-and-shaft assembly. Interaction of the two magnetic fields supports the moving system in a state of equilibrium.

Two stainless-steel guide pins—firmly held in the rame at the top and bottom of the shaft—maintain vertical alignment. They are inserted in graphite washers in the shaft and require no lubrication. The only bearing pressure is that caused by side thrust on he guide pins, and this is reduced greatly by having the damping magnets close to the electromagnet. Pressure never exceeds 100 psi whereas in conventional meter design the bearing pressure is 100 tons per square inch, or 2000 times as great.

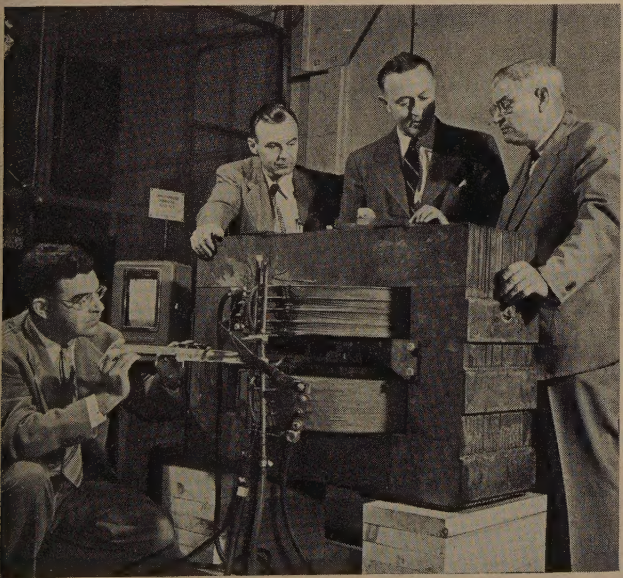


Fig. 5. Developmental magnet to be used in 60-in. cyclotron

The damping magnets are die-cast in position on the meter frame, assuring permanent alignment of parts and improving surge resistance. The current coils are molded in butyl rubber, with the rubber providing turn, coil, and ground insulation. The layer-wound potential coil is similarly molded in polyethylene plastic. The new meter has longer life, greatly improved performance, and lower maintenance costs.

Electric Instruments . . . *Many New Forms*

The internal-pivot mechanism previously used in small-size instruments was applied to thin 3½-in. instruments for panel mounting. They require only one inch behind the panel, and are for measuring direct currents and rectified and high-frequency alternating currents.

The a-c load visualizer was redesigned to increase its self-contained current range from 5 to 50 amp. The new one can be used with a split-core transformer without cutting conductors or interrupting service. It measures line amperes, volts, and reactive amperes directly; and by the use of a calculator card determines the watts, vars, and power factor.

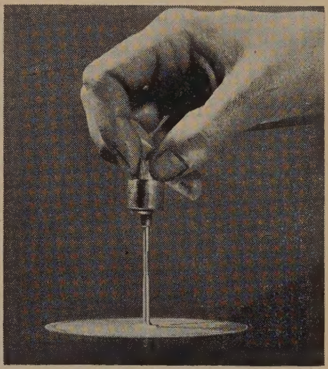


Fig. 6. Magnetically suspended rotating element of new watthour meter

Frequency-type telemetering equipment was developed for measuring kilowatts or kilovars over carrier channels. A watthour meter is the measuring element. The receiver can be an indicator or a recorder, or both.

Several other new instruments were announced by the engineers of the Meter and Instrument Divisions. Among these are included an expanded-scale voltmeter, in long-scale switchboard design, for central-station and industrial applications; a sensitive photoelectric recording wattmeter for a-c or d-c measurements up to 10 megacycles; a redesigned phase-sequence indicator with a protecting cover, improved neon lamps, and built-in test loads; and an electrostatic voltmeter in ratings up to 75 kv. A portable precision potentiometer for accurate measurement of extremely low voltages, is completely self-contained. The vacuum-tube voltmeter was redesigned with a linear instead of suppressed-linear scale, and improved frequency range and amplifier output.

Electromagnet . . . *Six-tonner*

Present research in nuclear physics and other scientific fields has accentuated the need for stronger and more uniform magnetic fields; accordingly electromagnets of considerably larger size and higher efficiency have been designed. A six-ton electromagnet (FIG. 7) built in the General Engineering and Consulting Laboratory for Rutgers University produces a field of 16,000 gauss across a 3½-in. gap with pole pieces of 19½ in. diameter. For such a flux density, the coils operate at a current density of 4000 amp per sq. in. with average coil temperature about 80 C. Water tubing is brazed on the inside and outside peripheries of copper disks with open centers, between the rows of windings.

Because of the influence of strong magnetic fields on certain salts, this electromagnet will help provide means of reaching temperatures near absolute zero. It will be used to study magnetic susceptibility at low temperatures, and also to investigate nuclear magnetic properties of various isotopes.

Regulated Power . . . *Really Close*

A special 50-kv regulated power supply was constructed. The equipment was developed to be used with x-ray and nuclear research equipment. It will hold accurately any d-c voltage from 500 to 5000 volts within 0.02 percent, and from 5000 to 50,000 volts within 0.02 percent to 0.15 percent over a range from zero to 1 ma output. The ripple voltage will never exceed 0.006 percent. It is completely temperature-compensated, and has a stability variation of less than 20 parts per million per minute in the lower-voltage range, and less than 100 parts per million with high voltage. Power supply is commercial 60-cycle, single-phase, 110/130 volts.

Magnetic Amplifiers . . . *And Other Devices*

Absence of moving parts and long life are characteristic of new magnetic amplifiers applicable to a wide variety of electric control problems. Their self-saturated magnetic circuits combine an a-c winding on a saturable-core reactor in series with a rectifier element. Small changes in power output to the d-c control winding on the saturable core produce large changes in the power output of the a-c winding. Such magnetic amplifiers (FIG. 8) are used in circuits measuring tension, speed, pressure, and flow. Coupled with a thermopile, it forms a flame detector to stop fuel flow to a burner if the flame goes out. The amplifier was developed in the General Engineering and Consulting Laboratory, which also announced a wide variety of additional electrical, mechanical, chemical, and other measurement instruments and devices during the year.

Among that laboratory's devices was a current-limited, high-potential tester for production testing of the insulation of small electrical units and appliances. It weighs only 25 lb and occupies approximately a 10-in. cube. Fast, nondestructive production testing of generator coils for voltage breakdown is done by a new induced-voltage tester. It has an equal turn-to-turn distribution of test voltage in the coil. An a-c permeability and core-loss device rapidly and accurately measures several magnetic properties of a small sample of metal, enabling engineers to predict the magnetic performance of that metal in finished equipment.

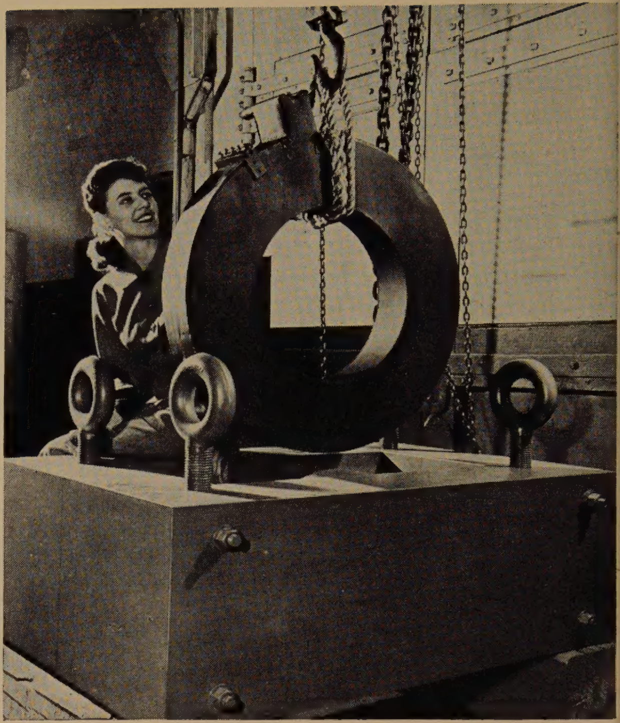


Fig. 7. Rutger's six-ton electromagnet has work to do in the near-absolute-zero field

MECHANICAL TESTS

Field Mapping . . . *Tedious Calculation*

FIELD mapping of heat flow, internal stress, magnetization, and other forces by calculation is tedious, often requiring days or even weeks for solution of a single problem. Field mapping any two-dimensional and many three-dimensional shapes is only a matter of hours, however, with a new automatic machine which plots lines representing the voltage surrounding an electrically charged test specimen. Operation is based on the principle that the uniform voltage lines have the same location as the lines of uniform temperature or strain in the metal.

Surfaces . . . *Super-vision*

Since it has the ability to detect corrosion before it is visible under the conventional microscope, the electron diffraction instrument has been particularly useful in selecting the best material for gas-turbine buckets. The instrument, for observing and measuring the conditions of a surface of any thin layer of materials, is a valuable tool in investigating corrosion, catalysts, lubricants, metals, pigments, surface deposits, and graphite.

A pocket-size roughness comparator weighs only 3 oz and is composed of two small metal rules, 6 in. long and 1¼ in. wide, with 24 areas grouped into 10 degrees of roughness ranging from a flame cut to a bearing-surface smoothness.

ibrations . . . *Measured, Recorded*

Mechanical vibrations in moving machinery, rotating
uipment, factory buildings, and the like are measured
id recorded by a new recording vibrometer. A short
etal prod extending from the side of the instrument
held against the vibrating object. The vibrations,
agnified 12 times by a spring, are recorded by a
ovable sapphire point on moving waxed-paper tape.
he curve shows frequency, amplitude, and wave shape
the vibration.

An instrument buried near the scene of test explo-
ons measures acceleration of explosion shock waves
assing through the earth. It contains crystals that
enerate a voltage when shocks are applied. Signals
e carried by wires to amplifiers and recorders above
round. The instrument can register shocks up to
500 g of as many as 20,000 cps. Four such instru-
ents supplied data when a half-million pounds of
igh-explosives was set off by TVA.

Fig. 8. Magnetic amplifier with no moving parts

ils . . . *And Greases*

An improved coil-turn counter gives increased range
measuring the number of turns in unmounted coils—
o to 60,000 turns with an accuracy of ¼ of one percent.
or production testing of a single type of coil, the scale
in be marked on a "go" or "no go" basis.

New equipment developed in co-operation with
STM rapidly tests ball-bearing greases for comparison
1 a performance basis. Users can maintain more
ficient lubrication by determining how often bearings
ould be lubricated. Among such users are several oil
fineries, an optical company, and a large metal
oducer.

CHEMICAL TESTS

eak Detector . . . *Really Sensitive*

ERHAPS the leak is so small that only one ounce
of Freon would escape in a century. Even so, an alarm
sounded by a new leak detector (FIG. 9). Based on
e principle that the emission of ions from the hot
filament of a sensitive element is increased by the presence of a halogen gas (including fluorine and chlorine), the instrument can be used wherever the unit to be tested, such as sealed piping systems or pressure containers, contains one of these gases, or where Freon can be injected to serve as a tracer.

Volatile Content . . . *Or Moisture*

A monitor for determining the percent volatile content of textile and plastic materials can measure, with proper adjustments, moisture as percentage of weight in paper, fabrics, rubber, rayon, and nylon. Volatile content is found by the relationship between dielectric constant and volatile present; moisture content by the change in a-c resistance.

Oil Resistivity . . . *Quickly, Easily*

Indication of the quality of mineral insulating oil used in high-voltage power cables and transformers is given quickly and easily with an oil-resistivity test set. The oil sample is heated by a steam jacket to 100 C, voltage is applied, and the very slight flow of current through the sample is detected and indicated on an instrument calibrated in resistivity.

TIMING DEVICES

Interval Timer . . . *In 2-min Range*

PHOTOGRAPHERS will be one of the groups most interested in an automatic timer having a two-minute range. It turns an enlarger or printer on and off automatically at the push of a button; resets itself for accurate repetition; and ticks off the seconds, making a distinct click at the end of each interval. Other models have time ranges, for other applications, of 0 to 15 min, 0 to 2 hr, and 0 to 12 hr. In a gray plastic case, it measures

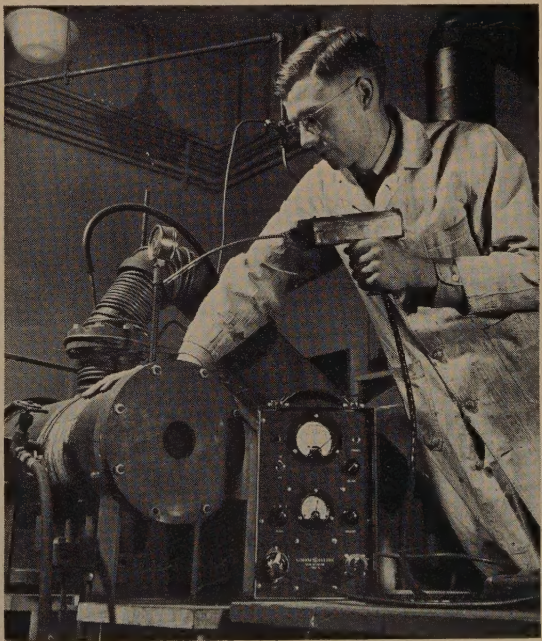


Fig. 9. This leak detector sounds an alarm if any halogen gas escapes to the atmosphere

6 by 6 by 3 in. and weighs two pounds. It operates on 110-volt 60-cycle current and has a 1200-watt capacity. Dial calibration is logarithmic for easy reading and accuracy in setting.

OPTICAL EQUIPMENTS

Totalux . . . *For Photo Processes*

A NEW totalux, for the photo process industries, quantitatively measures light of varying intensities and automatically times the exposure for the preselected amount of light. This means higher quality and more uniform work in photoengraving, lithographing, plate making, photo composing, and color separation.

Photolight . . . *It Stops 'Em*

A NEW high-speed photographic equipment catches images of objects moving at supersonic speeds. Its fundamental unit is a light source producing a flash of only two millionths of a second duration. The light source is a three-electrode, short-gap, high-pressure, inert-gas-filled tube with self-contained, fixed-focus, parabolic reflector and a capacitor-discharge type of power supply.

METEOROLOGICAL MEASUREMENTS

Hypsometry . . . *50,000 Ft and Higher*

A HYPSOMETER, for the benefit of some readers—and of the writer—is an instrument for determining height by finding the boiling point of a liquid. More accurate measurement of pressure at altitudes greater than 50,000 for further meteorological studies was made possible by a hypsometer in which a resistor with a large negative temperature coefficient is used to give an electrical indication of the saturated vapor pressure. Equal accuracy is obtained at any altitude throughout the range of the instrument. Liquids used include water, carbon disulfide, and antifreeze.

INDUSTRIAL X-RAYS

BROAD new fields of application for x-ray diffraction in the identification and quantitative analysis of unknown materials were opened by a high-precision, high-output machine (FIG. 10) announced by the General Electric X-Ray Corporation, Milwaukee. One of the many attachments comprising the complete assembly is a fluorescent analyzer; it greatly extends the range or composition of materials which can be analyzed, in comparison with that possible when using optical spectrometers.

Another group of attachments makes possible direct recording of x-ray intensities on a continuous strip of chart paper, thus saving countless hours of laboratory time, by revealing the angular placement of the characteristic lines of materials and their relative intensities. The new unit couples, for the first time, precision control of x-ray output with high x-ray intensity. Tube voltage is controlled to within 0.1 percent and tub current to within 0.02 percent, giving an x-ray intensit controllable and reproducible to an over-all accuracy 0.5 percent.

10,000,000-volt Betatron . . . *Fast Work*

A 10,000,000-volt betatron, produced at Schenectady was installed during the year at the Naval Ordnanc Laboratory, White Oaks (Md.), for special industria research radiography. It can x-ray rolled steel 10 in thick at a distance of 6 ft in 30 min—8 times as fas as the 2,000,000-volt equipment. A sensitivity of bette than 1 percent has been reported under these conditions. Only one second is required for one-inch stee Using tungstate intensifying screens, the unit can examine 15 in. of rolled or cast steel in one hour or less and still show a 2 percent sensitivity gage. Radiograph of extremely fine detail can be produced.

Shoe Fluoroscope . . . *Nails, Eject*

Adaptation of fluoroscopy to factory examination c shoes for unwanted nails, needed in shoes prior t stitching, was among the achievements. At Endicot Johnson Shoe Co., Endicott (N. Y.), this inspection i now accomplished by placing the shoes on a conveyo The operator merely watches the shoes as they go b and mechanically ejects those with unnecessary nails.

$250,000 Saving . . . *Chills Analyze*

The significance of x-rays as a money-saving tool c industry was brought out forcefully by the Ford Moto Company, which reported that the use of x-rays save it $250,000 in a year's production of one type of crank shaft. X-rays showed that the use of chills in the main of the crankshaft resulted in lack of fusion at the chil plus considerable breakage of drills directly attributabl to the use of chills. X-rays guided the experiments directed to the elimination of chills. The solution wa found by mounting four plates, 4 by 4 by ¾ in., on th bottom of the conveyor hangers, giving the desire directional solidification and permitting complete elimination of chills.

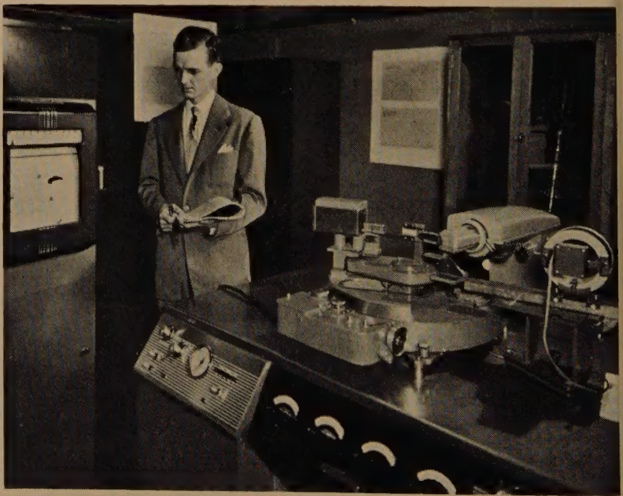
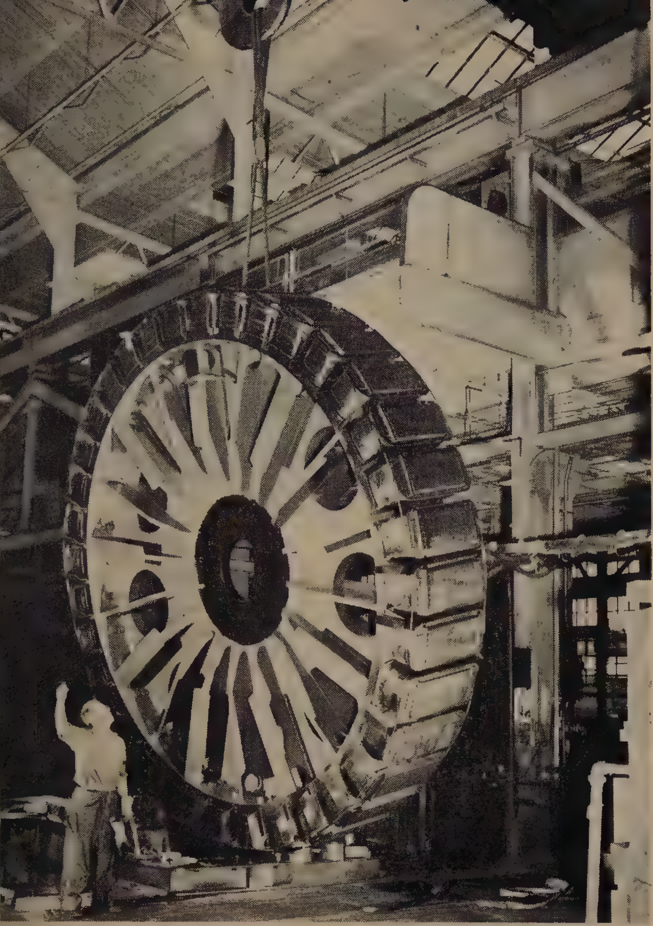


Fig. 10. Broad new fields are opened by this x-ray diffraction machine. Recording unit shown at left



One of the six rotors for Mexico City's 6000-kw diesel-driven gen-
rators. This is an example of the electrical machines that are being
uilt to supply the present huge demands for power

POWER

• • • • • • •

POWER GENERATION

Gas Turbines . . . *First Commercial*

A 4800-HORSEPOWER oil-fired gas-turbine power plant, specially designed for locomotives, was run n the factory for more than 700 hr. Construction was tarted on two 3500-kw units. Oklahoma Gas and Electric Company will operate one with natural gas, sing the exhaust gases to heat boiler feed-water nstead of extracting steam from an existing steam urbine. Such an arrangement contributes to both inreased power output and economical performance.

The 3500-kw unit for the Central Maine Power Corporation will be oil-fired and will be installed in a tation to replace a 2000-kw 1800-rpm steam unit.

Natural gas will be the fuel for two 5000-kw highfficiency turbine power plants for the Public Service Company of Oklahoma. Another on order for the Bangor Hydroelectric Company of Maine is a 5000-kw lant similar to these, but oil-fired.

esuperheat . . . . *Renewed Interest*

The past year saw renewed interest in the resupereating cycle, which has been applied to 2,000,000 kw f Schenectady-built turbines in the past two decades. Resuperheating the steam after partial expansion in the turbine enables a turbine having a particular size of exhaust to deliver more kilowatts. Heat consumption of the plant is better than in turbines with the same initial steam conditions but without resuperheating.

With rising prices and greatly increased power demands, it is necessary, more than ever, to obtain maximum capacity use of each machine and greatest efficiency from all sizes. Therefore, interest is again high in the resuperheating cycle. Seventeen units, with more than 1,500,000-kw capacity for the resuperheating cycle, are now being built at Schenectady.

1050 F Operation . . . *The First*

The first turbine (FRONTISPIECE) to operate at 1050 F—a 100,000-kw 3600-rpm tandem-compound triple flow unit—went into service in the new Sewaren station of Public Service Electric and Gas Company (New Jersey). Initial steam conditions are 1500 psig and 1050 F, and the exhaust pressure is 1.5 in. Hg abs. The last five stages are triple flow. Each of the three exhausts is of maximum size for 3600 rpm. The bucket peripheral speed is 1393 fps—or a supersonic 950 mph.

All turbine parts subjected to 1050 F steam are made of austenitic steel stabilized by addition of columbium and, in the case of castings, reinforced by adding molybdenum. The high-pressure section, with double-shell construction, is designed to limit use of austenitic material to the hotter stages. The turbine has eight points of steam extraction for feedwater heating, three inside the exhaust connection to the condenser.

Double-flow Turbines . . . *Power Shortage Relief*

The power shortage on the Pacific Coast, caused largely by an extended dry spell and resultant lack of water power, was relieved by installing several steam turbines. Two of these units, 100,000-kw 3600-rpm 24-stage tandem-compound double-flow turbines, were installed in Station P of the Pacific Gas and Electric Company. The Redondo Steam-Electric Power Station of the Southern California Edison Company also installed a 60,000-kw 3000/3600-rpm 20-stage steam turbine-generator (FIG. 11).

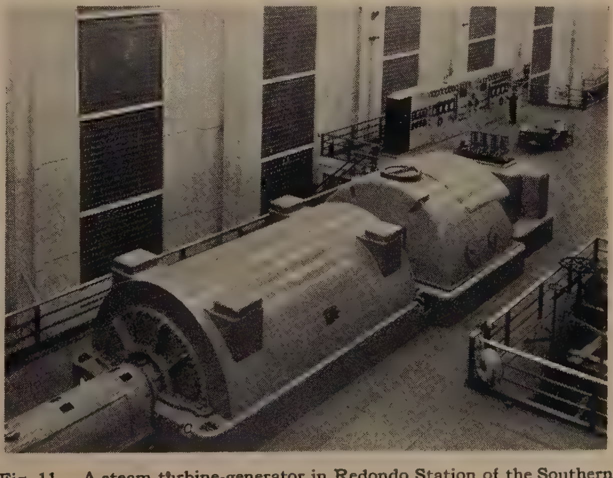


Fig. 11. A steam turbine-generator in Redondo Station of the Southern California Edison Company

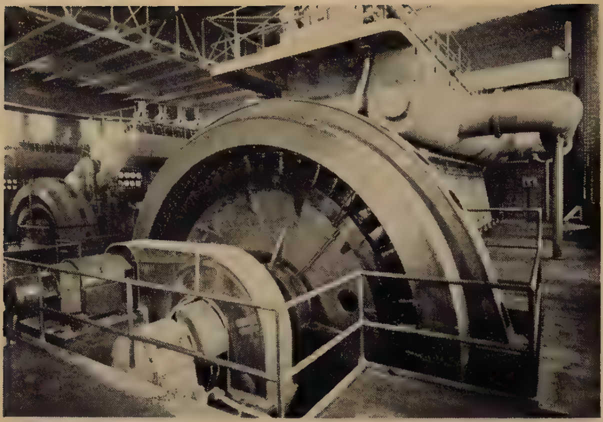


Fig. 12. Some of the rotor poles of this 5450-kw diesel-generator set had to be removed to permit transport by rail

Mechanical-drive Turbines . . . *Hydraulic Governing*

A new line of mechanical-drive turbines incorporates as standard equipment such large-turbine features as hydraulic governing, giving wider speed range and more accurate control, and pressure oiling of bearings. The turbine can drive pumps, compressors, fans, blowers, and similar equipment. Interchangeability of parts is a big feature of this new line of turbines. Whether the turbine is rated 20 hp or 1000 hp or whether it has a 16-, 20-, or 25-in. wheel size, many parts are the same.

Hydroelectric Generators . . . *2 Million Kva*

For large hydroelectric power plants being developed by government power agencies and many private electric power utilities, there is now either in process of installation or on order with General Electric over two million kva in hydraulic turbine-driven generators. Completion of these developments extends over the next three to four years and they will supply needed power generation to practically every sector of the United States.

Diesel-driven Generators . . . *Really Large*

Six of the largest diesel-driven generators ever built at Schenectady were installed by the Mexican Light and Power Company. Each is 22 ft in diameter, weighs 54 tons, and is rated 6000 kw at 167 rpm. They are designed for operation at 7450 ft elevation. The generators are driven by the largest diesel engines, in point of power output, ever constructed in the United States. Built by the Nordberg Manufacturing Company, Milwaukee, 18 railroad cars were required for each disassembled engine.

One of the largest diesel-generator sets installed in this country in recent years was that of the Iowa Light and Power Company (Fig. 12). It has a rating of 5450 kw, with net output of 5000 kw, since 450 kw is used to drive an induction motor-driven scavenging blower. The split-stator generator is about 20 ft in diameter and weighs 37,500 lb; the rotor is of one-piece fabricated-steel construction, 179 in. in diameter weighing 87,000 lb. It is driven by a Nordberg diesel engine.

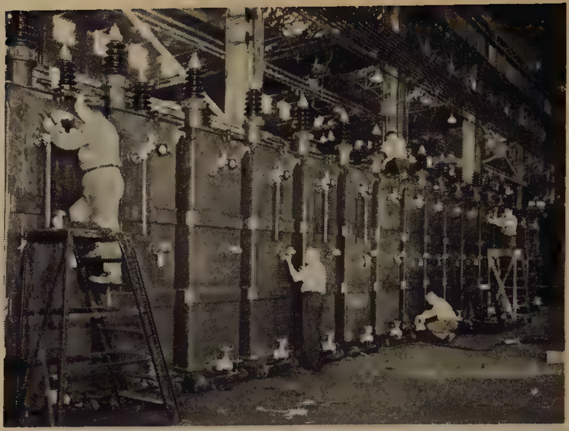


Fig. 13. Sixteen duplicate water-cooled power transformers being assembled

Power Station Auxiliaries . . . *Improved Rheosta*

Liquid rheostats were improved, making them more applicable to the control of wound-rotor induction motors for boiler feed pumps and draft-fan drives in power stations. They are operated by the pneumatic systems normally used for power-station boiler control, and provide a smooth speed control over a wide operating range, thus conforming to the new trend in auxiliary drives.

Approximately 60,000 hp in enclosed motors with top-mounted surface air coolers have been installed or ordered since 1946 for power-station auxiliaries.

TRANSFORMERS

Power Transformers . . . *Highest Rated*

THREE of the world's highest rated kva transformers, to be constructed for Detroit Edison Company, will not be the largest in terms of weights and

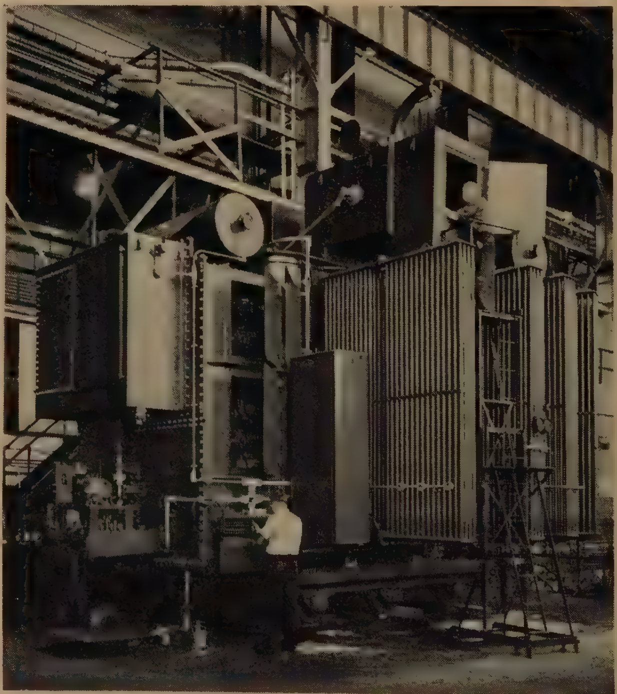


Fig. 14. Assembling a 40,000-kva 13,800- to 27,600-volt regulating autotransformer for the Consolidated Edison Company of New York

dimensions. This seeming paradox is because corisil steel is used for the magnetic cores, and forced-directed flow of the cooling liquid. These practices result in a lighter, more compact design. The transformers will raise the voltage from 15,000 to 135,000 volts, and each will be rated three-phase 145,000 kva.

Sixteen identical power transformers were built for a South American utility (FIG. 13). Each is rated single-phase 1250 kva 60 cycles 44,000 to 2300/4000 Y, and is water-cooled.

The new EEI-NEMA preferred voltage ratings were applied to RM (repetitive manufacture) power transformers, making the line suitable for even more widespread application and resulting in greater economies to purchasers.

Load-ratio control was supplied on a greater percentage of large power transformers; one of the most intricate applications involving four autotransformers for use on two tie-circuits between the Hell Gate and Waterside Stations of the Consolidated Edison Company of New York. Two of the installations regulate the phase angle, permitting ± 25-deg variation between input and output voltage; the other two (FIG. 14) compensate for ± 12 percent variation in output voltage.

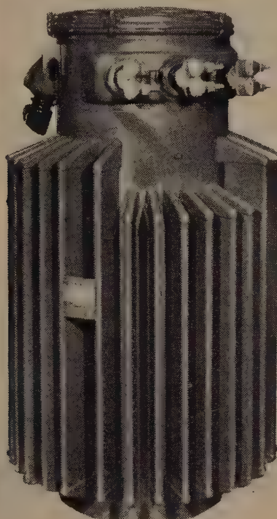
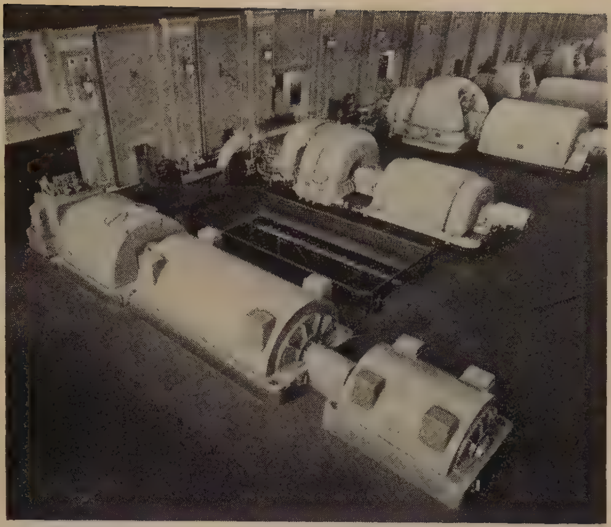


Fig. 15. The beaded-rim tank construction, such as shown here, now extends to the 100-kva sizes of distribution transformers

Distribution Transformers . . . *Beaded-rim Tank*

The sealed-tank design, employing a beaded-rim tank, flanged cover, and gasket of nitrile rubber, was extended during the year to include distribution transformers throughout sizes 100 kva and less, and 15,000 volts and below (FIG. 15).

The resilient nitrile rubber gasket, compressed between the tank bead and flanged rim of the cover, prevents entrance of moisture and other contaminants; thereby prolonging the insulating life of the liquid, and extending actual transformer life. The gaskets are used on all liquid-immersed, single- and three-phase distribution transformers. The tanks are finished with a melamine-modified Glyptal paint.



These units for the Public Service Electric and Gas Company (New Jersey) operate with initial temperature of 1000 F. They are similar in construction to those for Station P of the Pacific Gas and Electric Company but were built one year earlier

Specialty Transformers . . . *And Ballasts*

A "midget" indoor neon-sign transformer design effects a saving of nearly 50 percent in size and weight. It uses a new, highly efficient core-and-coil design, plus a novel case style.

For blueprinting applications and other places where mercury lamps must be maintained at a well stabilized level of light output there was developed a ballast based on the high-reactance principle, with a saturated core leg and capacitors used as regulating elements. The 1200-watt UA-4 lamp wattage variations are held to 2½ percent with input voltage varying from 100 to 130 volts. The 3000-watt H-9 lamp has the same output control between 200 and 260 volts.

A 28-volt d-c supply develops 25,000 peak volts in a new inverter transformer weighing only 8½ lb, including the vibrator. It is used to fire gasoline aircraft cabin heaters.

A new automatic voltage stabilizer was produced for use as a component in various types of electric equipment requiring small amounts of closely regulated power, in ratings of 15, 25, and 50 va. Output voltage variations are limited to less than ± 1 percent, while input varies from 95 to 130 volts. Response is less than three cycles.

TRANSMISSION

Tidd Project . . . *New Needs*

THE demands of steadily increasing power requirements have led to much activity in the field of extremely high transmission voltages. This, in turn, has led to the natural development of new and better insulators for these purposes.

For the Tidd Test line, built by the American Gas and Electric Service Corporation at Brilliant (Ohio), Locke Incorporated of Baltimore supplied suspension insulators, special articulated conductor clamps which minimize the hazards of conductor vibration and fatigue, and corona shields.

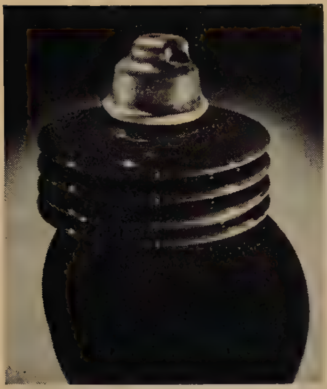
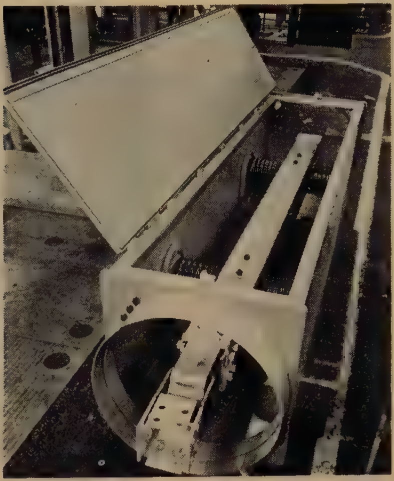


Fig. 16. A new suspension insulator for use in dirty or foggy areas. Note that the design allows for maximum ease of cleaning

Fig. 17. Providing maximum reliability for connections between switchgear and generators and outgoing circuits, this isolated bus bar is readily inspected



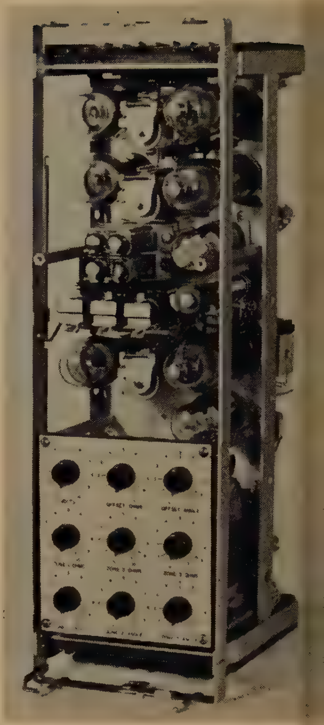


Fig. 18. This electronic mho relay, shown removed from its case, possesses characteristics equal to, and in several particulars superior to, those of similar electromagnetic relays

New Insulators . . . *No Dirt—No Bugs*

Another contribution to higher-voltage transmission was a transformer bushing, the top half of which, standing more than 10 ft high, is believed to be one of the largest pieces of electrical porcelain ever made.

The fog-type suspension insulator (Fig. 16) was developed by Locke for use in dirty or foggy areas. It provides high leakage distances, properly balanced with parallel air gaps. Surfaces are arranged for maximum ease of cleaning by wind, rain, or manually.

Wood guy strain insulators are used commonly for the supplementary lightning insulation of transmission lines. Since they are subject to splitting caused by lightning discharges, burning from leakage currents, and exposure to rot and insect infestation, a porcelain guy strain insulator was developed. It is free from the hazards mentioned, and provides more impulse insulation per unit of length.

Thermal Zircon . . . *Unusually Promising*

A new ceramic material, developed by Locke, has unusual promise for thermal applications. The material, which has a zircon base, combines relatively high mechanical strength, ease of manufacture, and high resistance to thermal shock. Its electrical insulating properties at high temperatures are good, but, since it has some porosity, it is not suitable for the manufacture of outdoor, high-voltage insulators. Samples have withstood successfully the thermal shock of quenching from red heat to cold water.

SWITCHGEAR

SWITCHGEAR developments during the year emphasized completely co-ordinated factory-built equipments. Newly developed devices were designed to fit in as components of co-ordinated equipments rather than as unrelated items.

Generation and Transmission . . . *Ratings U*

There was a phenomenal increase in the interrupting rating of commercial high-voltage power circuit breakers—nine completely co-ordinated factory-built 230-kv switchgear units were designed with an interrupting rating of 10,000,000 kva. Highest rating previously available was 3,500,000 kva. They will control the output of the second nine 108,000-kw generators in the north powerhouse of Grand Coulee. Each will combine a complete three-pole circuit breaker, bushing current transformers, safety interlocked disconnecting switches, and all interconnections in a single integral structure.

Improved appearance, reduced maintenance and greater reliability resulted from changes in high-capacity, totally enclosed, air-blast breaker, station-type switchgear rated at 15 kv in interrupting ratings up to 2,500,000 kva. Air pressure of 250 psi insures interruption of faults on the first current-zero after the contacts part.

Co-ordinated with this development was the completion of a full line of a new design of dust-tight, isolated-phase bus (Fig. 17), with each conductor in its own aluminum enclosure.

In the field of transmission-line protection, initial steps were taken into the field of electronic protective relaying; speed and accuracy requirements of future protective relays may soon exceed the inherent limitations of electromagnetic relays. A complete terminal of electronic mho distance relays (Fig. 18) was developed for installation on a transmission line of an operating utility, to obtain performance data under service.

Power Distribution . . . *From Liability to Asse*

The saturation phenomenon of current transformers, previously a liability, has become an asset in a new bus differential protective relay. It is free from the ıy difficulties arising from the saturation charac- stics of bushing current transformers, to which er types have been subject. It utilizes standard hing current transformers, is insensitive to through- t currents, is sensitive to very low bus-fault cur- ts, and is a high-speed device.

more efficient interrupter of the dual-flow, cross- st type, provided in a new line of tank-type outdoor circuit breakers, has given higher interrupting speed longer contact life. Solder-sealed bushings should ctically eliminate external maintenance.

roup-operated vertical-break disconnecting switches .5 to 69-kv ratings were given the principal features he higher-voltage switches introduced the previous r. They are of the three-insulator-per-pole type, h the blade rotated about its longitudinal axis to ain contact pressure and blade locking. All braids eliminated from the current path. Silver pressure tacts are used throughout.

'or some time there has been a demand for a manu- operated closing device for magnetic power circuit akers for 13.8 kv and below, 500,000 kva and below, ticularly for isolated distribution substations where maintenance of storage batteries or the provision control-power transformers has been a major prob- . A new, manually charged, stored-energy spring- rated closing mechanism for magne-blast breakers developed, which will close and latch the breaker inst the maximum rated momentary current of the aker. It is available for magne-blast breakers rated v, 100,000 through 150,000 kva and 15 kv, 150,000 ough 500,000 kva, interrupting rating.

'or isolating and protecting primary circuits of trans- ners in master unit substations, new metal-clad tchgear units, rated up to 15 kv, embody an air ating and magnetizing current interrupting switch, interlocked with transformer secondary breakers, current-limiting fuses for transformer protection. switch is operated from the outside, providing ximum safety. A similar type of switch was added a line of metal-clad switchgear units with feeder tage regulator by-pass and disconnecting switches. gnetic-blowout isolating switches have replaced fan- le disconnecting switches for the by-pass and dis- necting functions.

n the field of low-voltage distribution there was de- oped a line of sturdy, compact 3-phase 60-cycle rent-limiting reactors in ratings up to 600 volts and amp.

ays . . . *And Analyzers*

Draw-out relays now have a single line of enclosing es, for either semiflush or surface mounting. The get-reset device is entirely in the cover, and the porting frame of the relay has been simplified to vide better access to the parts. The new portable plug provides easily accessible and completely ntified binding posts for attaching test leads.

mproved master and generator instrumentation, re accurate and finer adjustments on all components, push-button selection of meter readings, and complete factory assembly and test are features of the newest a-c network analyzer. The analyzer is designed primarily for the solution of the many complex problems associated with power-system design and operation.

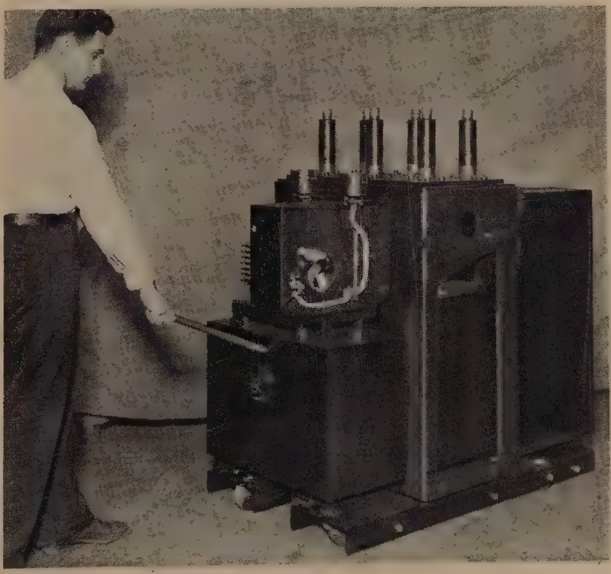
UNIT EQUIPMENTS

Unit Power Plants . . . *First Postwar Mercury*

THE first postwar mercury unit power plant went into service in New England, as a topping plant producing 15,000 kw from the mercury turbine generator and providing some 200,000 lb of steam at 400-lb pressure to drive existing steam turbines. It replaced a smaller, obsolete mercury plant. The unit equipment includes the mercury boiler and associated equipment, mercury turbine generator, condenser boiler, piping, and control equipment, co-ordinated electrically and mechanically and thus effecting considerable saving to the operator. A number of such power plants will be installed during the coming year.

The first hydro unit power plant, rated 18,750 kva, went into operation in northern New England. It consists of a hydraulic turbine-driven generator, generator-voltage switchgear, main power transformer, outdoor station structure, and station service supply. The generator is directly connected to the indoor switchgear through an auxiliary compartment, and the indoor switchgear, in turn, is connected to the outdoor power transformer through a metal-enclosed bus run. Over-all time and expense on the part of the purchaser was reduced because one set of specifications covered all of the electrical equipment required. Detailed co-ordination was done by the manufacturer, and a maximum amount of factory assembly was employed, thus reducing installation expense. The year also saw installation of several single-unit plants of smaller capacity and a two-unit station of 24,000 kva.

A 15,000-volt 1200-amp magne-blast circuit breaker, equipped with manually charged stored-energy operator



Unit Substations . . . *Load-center Acceptance*

A major design change in load-center unit substations effects more flexible application and improves the substation's appearance. Both the dry-type and liquid-filled transformers were redesigned for integral connection to the low-voltage switchgear by a full-length transition compartment. The kva ratings and voltage ratios of load-center units were standardized, based on actual industrial requirements.

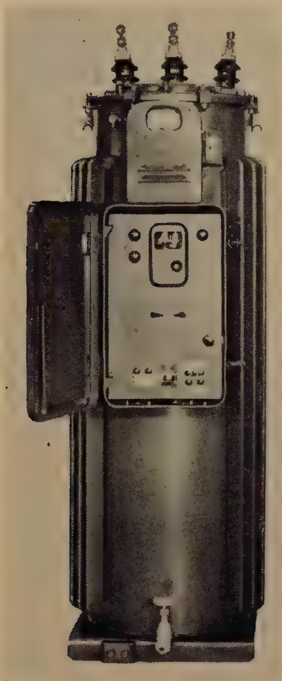


Fig. 19. A new induction voltage regulator

CAPACITORS

A NEW low-cost 3-kvar pole-type outdoor capacitor, for use on secondary distribution circuits, was made available at a price per kvar approximately 60 percent of that for previously available 240-volt capacitors. It permits economically sound use of capacitors for on-the-spot kilovar generation on secondary distribution circuits. The 25-kvar pole-type outdoor capacitor unit was applied during the year to large housed capacitor equipments.

CUTOUTS AND RECLOSERS

Enclosed Fuse Cutouts . . . *Heavy-duty*

A NEW heavy-duty 5000-volt 50-amp enclosed indicating fuse cutout, for application to distribution feeders of high power capacity, has an interrupting rating of 5000 amp rms at 5 kv, and 8000 amp rms at 2.5 kv. It is particularly adaptable for fusing distribution transformers, or for line sectionalizing where continuous load currents are not in excess of 50 amp, but where available short circuit currents require high interrupting capacity.

Automatic Recloser . . . *For Rural Lines*

Reduced operating costs and better continuity of service on rural lines have been provided by a new relayed automatic recloser which features high accuracy in time-current characteristics and a wider range of co-ordination between reclosers, and between reclose and fuses. It is available in six continuous-curren ratings from 5 to 50 amp, and can be used on 2400- t 15,000-volt circuits where the short-circuit current doe not exceed 1200 amp rms.

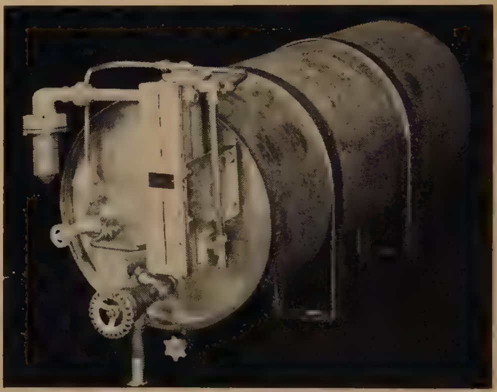
For complete flexibility of application, there is choice of two operating functions: two instantaneou openings, plus two time-delay openings to lock open; c two instantaneous openings to lock closed.

VOLTAGE REGULATORS

Induction Regulators . . . *Designed by Reque*

THE design of a new induction voltage regulator fo distribution circuits (Fig. 19) was based on a diges of comments from central-station engineers. Installa tion has been simplified; a new rectangular base allow ample clearance for jacking, and permits movement o rollers in any direction. The clamp-type bushing te minals accommodate a wider range of cable sizes, an the copper-faced ground pad has bolts spaced fo NEMA terminals. Maintenance and testing are sin plified. The entire control panel swings open, exposin all wiring and connections. Adjustment for holdin effect in the voltage-regulating relay has been mad easier by a single-dial rheostat.

Fig. 20. Oil reservoir of fabricated construction, shown with oil-level relay assembled



A triplex unit, consisting of three of these regulator mounted in a single tank and operated from a commo control system, was made available for three-phas applications. Both single- and three-phase units ar available with Pyranol insulating liquid for applica tions where fire hazards exist.

CABLE

High-voltage Cable . . . *First of Their Kin*

SEVERAL installations of high-voltage cable durin the year represent the first of their kind. High-pres sure gas-filled cables of the pipe type, and of mass-im pregnated construction, were installed and are operatin successfully; the only previous gas-filled pipe-type cabl installation in this country was of the preimpregnate variety.

It also became feasible to use a Neoprene jacket fo the outer sheath in the reinforced construction of sel contained gas-filled or oil-filled cable of other than th low-pressure gas-filled type.

erial . . . *And Portable*

Stainless steel was applied as the covering for pre- sembled aerial cable, resulting in greater resistance to echanical damage, weather, and corrosive atmos- eres than that provided by nonferrous tapes.

There were two important advances in flexible, rtable cables: temperatures as low as −60 F cause difficulty with a new design of butyl synthetic insula- on and jacket; heat-resistant insulation was incor- rated into others, raising their temperature rating m 60 C to 75 C, thereby increasing current-carrying pacity without increase in conductor or over-all size.

For even higher current-carrying capacities, a newly signed rubber power cable with super Coronol in- ation was made available.

ble Accessories . . . *Sturdier Reservoir*

A new type of oil reservoir (Fig. 20) for all types of rvice on cable joints and terminals is more compact; ore universal in application; sturdier in construction, d less costly. The tank is of sheet steel and is fabri- ted by welding.

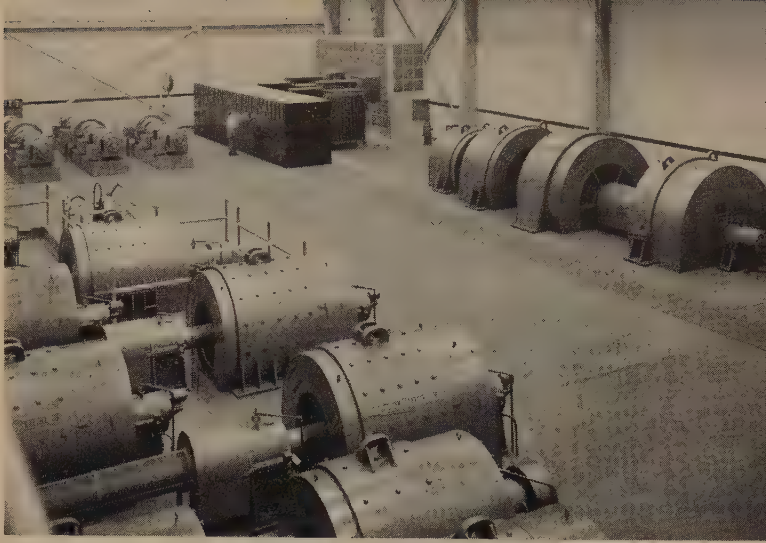
CARRIER CURRENT

wer-line Carrier . . . *Extremely Selective*

A NEW line of power-line carrier-current equipment was developed during the year enabling long- tance transmission of various control signals such as emetering, load control, transfer trip, and supervisory ntrol. The extreme selectivity of its sensitive re- vers is provided by quartz crystals, and the narrow nd width permits several of these individual control annels to be tucked away into a small portion of the er-all frequency spectrum.

ter-heater Control . . . *Watching the Load*

Several installations were made during the year of note-controlled water heaters which use 720-cycle nals transmitted over power lines. Although such a eme was used before, the system now provides auto- tic control based on substation load. Water heaters shut off automatically whenever the peak load of the tion occurs, and are turned on when the load sub- es. This process is carried on in small steps, minimiz- the effect of an increase in load.



Jones and Laughlin, Aliquippa (Pa.), has installed the world's fastest cold-strip mill; the drive has a total rated capacity of 16,850 hp. In such large-scale production, and variously in other fields, motors are used for the manufacture of the basic materials and the innumerable products of modern industry

INDUSTRY

• • • • • • • •

MOTORS AND GENERATORS

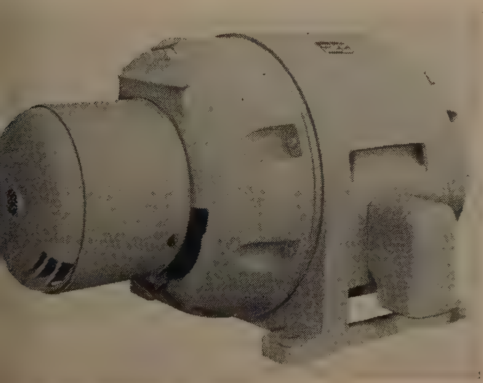
Synchronous Motors . . . *Tri-Clad Dripproof*

A NEW line of high-speed synchronous motors and generators in Tri-Clad dripproof construction was developed (Fig. 21). Ratings available are: motors, 20 to 1500 hp at 1800 rpm; and generators, 1.25 to 1250 kva at 1800 rpm with proportionate ratings through 514 rpm. Direct-connected overhung exciters are available for all ratings.

Before the conception of these new Tri-Clad machines, there had been no standard information available for the engine builder concerning construction or dimensions of generators for this use. This new information should help in initial engine design, and thus result in a more satisfactory engine-generator unit. The new generators are readily adaptable to the majority of standard engines on the market today.

Unit-cooled Motors . . . *No Ducts*

Usefulness of large unit-cooled d-c motors was greatly extended to cover the requirements of Ward-Leonard continuously rated drives by means of a new



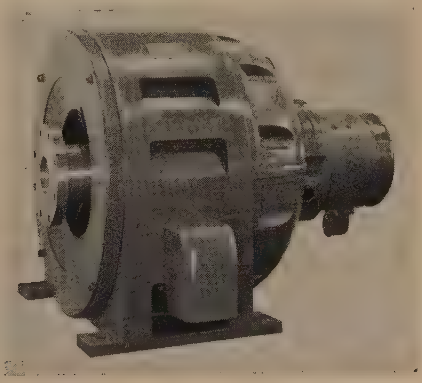


Fig. 21. Tri-Clad construction in synchronous units. Standard a-c motor (*left*); engine-driven generator (*right*)

type of cooler assembly (Fig. 22). Separate blowers driven by a single induction motor circulate both internal and external ventilating air. Cooling is independent of motor speed. Full torque is available down to practically zero speed continuously, with no derating from standard open frame.

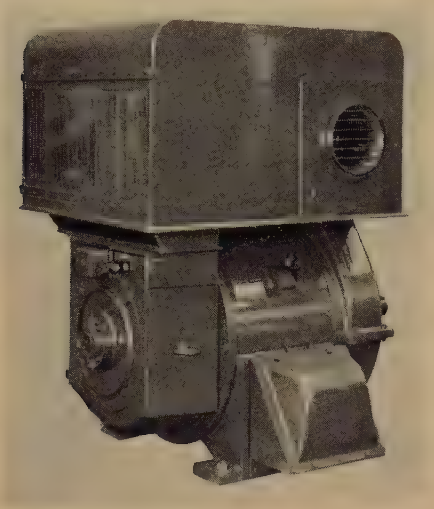


Fig. 22. A horizontal totally enclosed unit-cooled d-c motor with forced circulation of internal and external ventilating air

Fan-cooled . . . *Corrosion-resistant*

Corrosion-resistant Textolite molding compound was used for cooling fans of Tri-Clad totally enclosed fan-cooled motors of 1 to 20 hp. The fan is nonsparking; thus it was also incorporated in totally enclosed motors for hazardous gas or dust locations.

Other New Designs . . . *120 C Temp Rise*

A 60-kw high-temperature silicone-insulated d-c generator, rated 1800 rpm, 120/240 volts, was designed for a temperature rise of 120 C. The MD-600 line of heavy-duty d-c mill motors was extended in ratings and voltages, and units were made available in back-geared vertical shunt-wound and adjustable-speed units. A high-speed motor to drive propellers in wind tunnels features a revolutionary cooling principle in which water is pumped through the coil in rectangular conductors.

Two 200-hp 1500/3600-rpm, vertical inductor dynamometers shipped to the Byron Jackson Co. incorporate a low-movement air-pressure-cell force measuring equipment. The stator movement is so small that it was possible to suspend it on small rods within an outer frame, rather than on bearings, with resultant lower friction of stator rotation.

The Speed Variator, for precise control of d-c motor speed, was produced as a packaged unit. The streamlined enclosing case, containing all control and the m-g set, can be located at any desired distance from the machine on which the d-c driving motor is used. The line includes 3-, 5-, 7½-, 10-, and 15-hp sizes, and will include both larger and smaller ones.

Adjustable-speed Canning . . . *Production Speeded*

The first installation of a Tri-Clad adjustable-speed motor was made on a canning machine, with immediate outstanding advantages. The motor's 3:1 adjustable operating speed permits the filling of cans at a rat from 100 to 300 a minute. Attention required from a operator is greatly reduced by the adjustable-spee drive. With old-type motors it was necessary to sto operation before washing down the apparatus; now th speed can be reduced to about 100 cans per minute an the machine washed while the canning continues.

Other Applications . . . *Largest for Hoi*

The motor driving an ore hoist will be connecte directly to the drum of the ore hoist. Rated 3000 h at 60 rpm, the hoist motor will be the largest in siz yet built.

A synchronous motor installed to drive a reciprocating compressor is believed to be the largest in horse power (4500 hp at 300 rpm) ever applied for this purpose

Motors—24 of them—to drive two 12-stand close coupled seamless-tube mills were designed with an ey toward the future. If experience shows need for improvement of transient speed characteristics, a flywheel can be added conveniently; provisions are insid the coupling-end bearing bracket for the mounting The motors are rated 200 hp, 850/1700 rpm, 600 volts

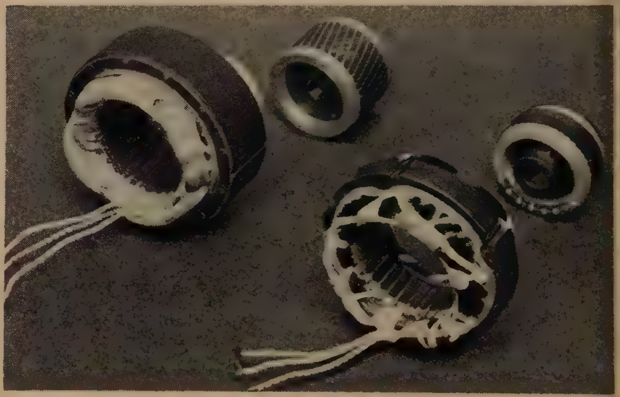


Fig. 23. The punchings of special design are welded together in a new hermetic motor. Comparison of old (left) and new construction

Fractional Horsepower . . . *Parts Standardize*

Small series-wound motor parts are usually mounte into purchasers' housings integral with portable drill and saws, vacuum cleaners, sprayers, food mixers, etc NEMA soon will publish the recently adopted standards for such parts. These standards cover essentia mounting dimensions including stacking lengths, winding heights, commutator diameters, brush sizes, brush mechanism mounting dimensions, and other similar details. In the meantime, General Electric has prepare a dimensional sheet to assist in the applying of standardized parts. Not only have variations been reduce greatly but, in most instances, designs have been improved.

A new series-wound universal motor in the BA3 frame has a two-piece die-cast aluminum case instea of the previous three-piece rolled shell frame. Th brush mechanism was changed to increase brush lif

An outstanding size reduction in hermetic moto was achieved by an improved electrical design and th levelopment of a new method of assembly of the stator unchings. They are welded together at intervals round the periphery, eliminating the shell (Fig. 23).

A small light-weight constant-speed motor for elecric typewriters and business machines has a newly leveloped external, momentary start-stop switch that erves also as a line switch and built-in overload proector. The stator assembly is a welded laminated core ressed into an expanded shell. The new 1/40 hp motor s 4.64 in. long and weighs 4 lb.

CONTROL

lotor Starters . . . *"Strong-box" Coil*

A "STRONG-BOX" magnetic coil—so called because the winding is so thoroughly protected—is a feature f a group of a-c contactors that is the heart of a new ine of full-voltage magnetic motor starters. A plastic enlosure gives protection to the coil windings against umidity, dirt, and oil, as well as mechanical protection uring handling and installation. Laboratory tests indiate a life expectancy of the coil about twice that of a onventional coil.

The new terminal clamp consists of a screw, lock vasher, and clamp-unit assembly. The combination tarter (Fig. 24), providing short-circuit protection y means of fuses, has a smaller disconnect switch that ermits an easy change of fuse sizes. The door, interocked with the disconnect switch, cannot be opened vith power on. An interference-type interlock on the eversing starter prevents one contactor from closing vhile an arc is maintained on the other.

Fast action and greater reliability on overloads was rovided in manually operated switches by the use of bimetallic tripping device. The molded base and ack cover are moisture-resisting, and all parts of the witch rust-resisting. General-purpose, watertight, and xplosion-proof types are included.

An oiltight push-button unit was made with a built-n jog latch. A standard-duty, general-purpose, pushutton switch was provided with a selector switch and s available in either double-pole, single-throw or singleole, double-throw.

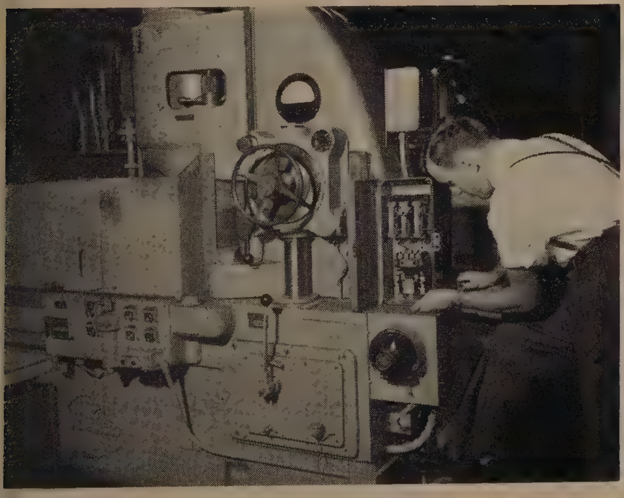
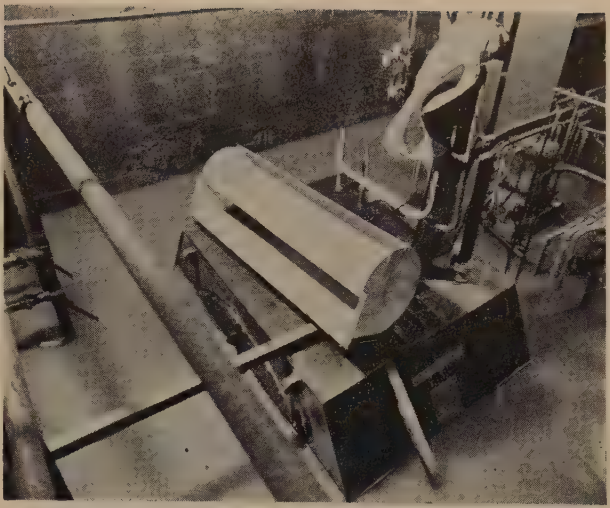


Fig. 24. This machine tool is equipped with a new type of combination starter



This 2300-hp motor installed at the Crown-Zellerbach Paper Company's mill on the Willamette River in Oregon, was prepared for submersion . . . . and got it. When the water receded, the motor was found to be undamaged

A new 5000-volt limitamp starter is smaller but has higher insulation and interrupting ratings. Starters with air-break or oil-immersed contactors can be interchanged space-wise.

Other Controls . . . *Stepless Speed*

For smooth, stepless speed control of lathes, grinders, conveyors and mixers there is a midget Thy-mo-trol, a small, adjustable-speed drive giving d-c flexibility from a-c power. The speed range is from 86 to 1725 rpm. Reversing or nonreversing drives were made available for loads up to ½ hp, 220 volts, 60 cycles.

A timing range of from 0.06 to 120 sec is spanned by three groups of electronic timers for operation, limit, or sequence timing. An industrial-type telephone relay permits direct control of power circuits, eliminating auxiliary relays.

An increased number of steps of resistance and a greater watt capacity can be obtained by using some new metal-clad plate-type field rheostat cases in 6-, 9-, and 12-in. sizes. Accessories include a mechanism for motor operation, a sprocket mechanism for chain operation, a mechanism for sequence operation, and one for concentric operation.

A new photoelectric smoke-density equipment has indicating lights which show at a glance whether chimney smoke is excessive, and an indicating meter which measures smoke intensity. The equipment will ring an alarm or operate motors to reduce excessive smoke.

A new static magnetic regulator gives control of speed in both directions between zero and maximum within 1 percent accuracy. A centrifugal speed relay, which sets tripping speed at any value in the running range, can be adjusted during operation. The amplidyne regulator for power-generating stations was redesigned to permit a low limit of excitation and a new frequency-compensating circuit.

Electronic voltage regulators were installed to give highly accurate voltage control of printing machines used for the printing of motion pictures and color films.

Accurate reproductions of prints are possible because the regulator maintains constant light intensity.

A completely static magnetic voltage regulator for 9600-cycle induction heating was used to regulate generators for industrial heating.

Type A Switch . . . *Unusually Compact*

A new front-operated Type A switch announced by Trumbull combines unique unit-pole construction feature in an unusually compact enclosure. It is for use as a motor-circuit disconnect, motor controller, main-entrance switch, and as sectional disconnect for buildings and factories.

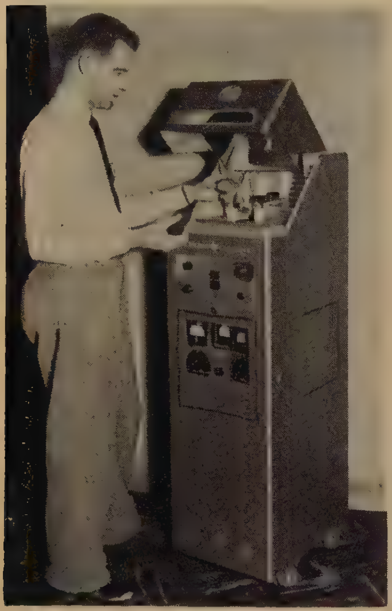


Fig. 25. This 3-kw dielectric heater occupies only 2¼ sq ft of floor space, and it is readily moved from one molding press to another

INDUSTRIAL WIRING

Plug-in Busway . . . *50-amp Capacity*

FLEX-A-POWER, a plug-in or trolley busway designed primarily for lighting and small power outlets was made available in 50-amp capacity by The Trumbull Electric Manufacturing Company. By use of this system, light fixtures are supported from the housing, and power take-off is accomplished by means of standard plugs. The new trolley is especially applicable for fluorescent lighting fixtures. Mobile power tools may be fed from the busway, with fusing protection provided. Plugs and trolleys are rated 15 amp and are polarized so that the phase is predetermined, thus providing a simple method of balancing the load between phases.

INDUSTRIAL HEATING

Induction Heating . . . *Selective*

INDUCTION heating methods during the year continued to find many new applications in industry for annealing, brazing, and soldering. A typical improvement was that by a manufacturer of calculating machines who found that freedom from distortion with induction heating methods eliminated grinding operations previously required after conventional heat-treatment methods. A cost reduction and an improved product resulted.

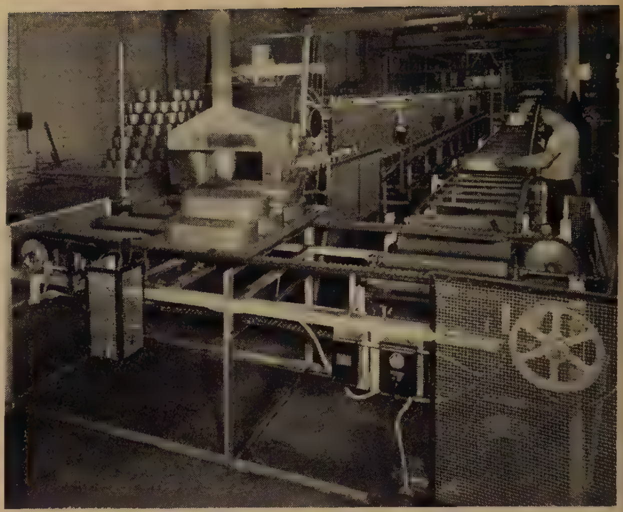


Fig. 26. Bright annealing in a roller-hearth furnace accomplishes in one operation that which required seven by pickling

Typical of special-purpose mechanized induction-heating equipments for high production of similar parts were those installed in production lines of manufacturers of farm machinery, automobiles, washing machines, refrigerators, etc.

A new 3-kw 40-megacycle dielectric heater was introduced for preheating plastic preforms. It is compact, (Fig. 25) easy to operate, and is readily accessible for maintenance.

Moisture content of twisted paper twine as wound in cones should be approximately 10 percent for quality-control purposes, but a variation from 10 to 25 percent is frequently encountered. A conveyor-type oven in which the cones are progressed between electrodes for dielectric heating at 27 megacycles provided the solution to the problem. Three 20-kw oscillators, mounted directly above the oven, supply the power. More than 1000 lb of cones an hour are dried to the required moisture content.

Furnaces . . . *Instead of Pickling*

A roller-hearth furnace (Fig. 26) is accomplishing in one operation that which previously required seven. Heretofore, pickling was the usual method for treating and preparing metal surfaces for porcelain enameling; today, the furnace turns out a product surface not only equal to that obtained by pickling but in some ways superior.

Electric glass melting was a new application for the Reactrol system of temperature control based on the use of saturable reactors. Use is made of the conductivity of glass in the molten state by passing current through the glass.

WELDING

Arc Welding . . . *Low Hydrogen Trend*

A MAJOR trend during 1948 was the use of low hydrogen covering for arc-welding electrodes, to facilitate the fabrication of hard-to-weld metals. Among

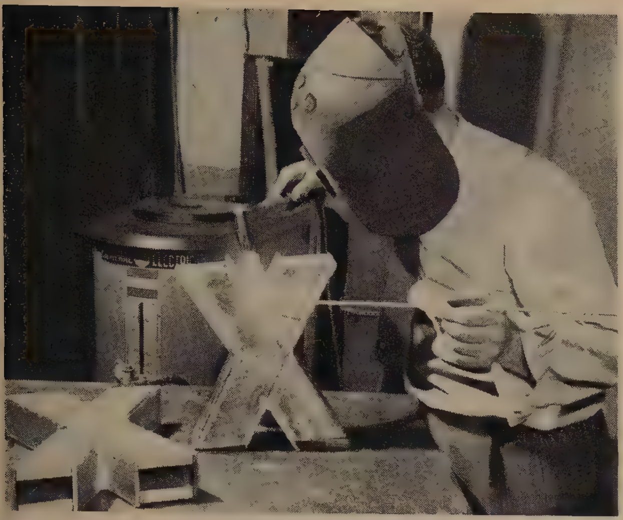


Fig. 27. An inert-arc welding transformer with idlematic control provides the power for a welder who is fabricating an aluminum stand for a retracting machine

ew electrodes in this development have been the ype W-32 for mild and low-alloy steels; Type W-60 or high-tensile steels of high hardenability; Type W-61 or the fabrication of piping to withstand high pressures nd temperatures; and Type W-62 for welding 2½ ercent nickel castings and for applications involving w-temperature service where high impact values are equired.

In the field of new equipments, probably the most teresting trend has been to the widespread use of elding generators on commercial jeeps.

Applications marking noteworthy advances included e wide application of inert-gas-shielded arc welding light metals (FIG. 27), previously considered not eldable by electric arc. Inert arc-welding equipments so made possible the welding of heavy aluminum ctions (up to 3 in. thickness) for heat exchangers d other apparatus required for special processes in e petroleum and chemical industries.

esistance Welding . . . *For Aluminum Alloy*

To reduce kva demand where power supply is mited, a three-phase resistance-welding control of the equency-changer type was developed. The control onverts three-phase 60-cycle power with an improved ower factor and distribution of the power over the ree phases. The control equipment can be mounted rectly on the side of the resistance-welding machine, mplifying installation and shipment, and improving ppearance. Control is entirely electronic, excepting e relay for operating the solenoid valve. Timing curacy is thus assured, and maintenance reduced onsiderably.

Recent tests with single-phase equipment have indi- ted that the life of the electrode tips may be increased to 10 fold, when welding aluminum alloys, by using "slope control," an attachment for use with standard sistance welding control which has electronic heat ntrol. The new equipment (FIG. 28) electronically ries the welding current gradually from an initial w value during the formation of the weld.

A new smaller size NEMA Type N2 nonsynchronous combination control with improved timing accuracy and greater speed utilizes only two relays: one for operation of the solenoid valve; the other for firing the ignitron tubes.

POWER ELECTRONICS

Sealed Ignitron Rectifiers . . . *First Extensive Use*

FIRST extensive use of the sealed ignitron rectifier tube, Type GL-507, was made during the year. Installations totalling more than 25,000 kw were engineered, and 8000 kw of this installed. The users included railways, mining companies, stores, office buildings, and industrial plants, among which, incidentally, was General Electric, installing four 500-kw units in its new turbine building at Schenectady.

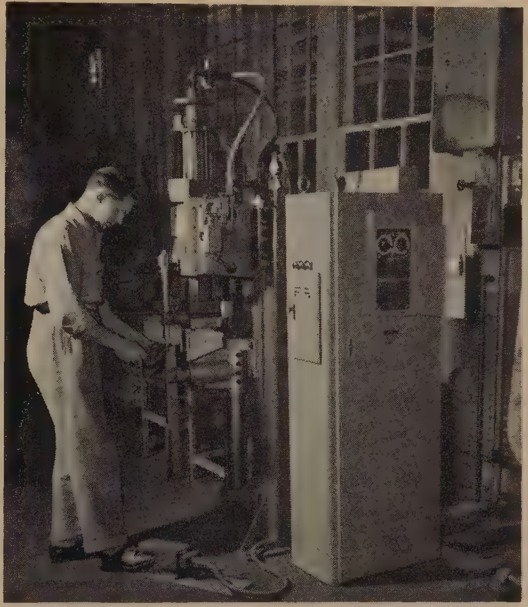


Fig. 28. Electrode tips last 5 to 10 times as long with a new "slope control" for resistance welding

PRECIPITATORS

Fly-ash Precipitation . . . *More Automatic*

ONE of the year's electronically controlled rectifier equipments for precipitation service for the removal of fly ash, etc., from a smoke stack is believed to have more automatic features than any previous equipment used for similar purpose. As the collector plates become loaded, overcurrents occur. If these occur at too high a rate this equipment automatically will cause the plates to be rapped and dirt collected to be removed from the plates. In addition to the usual overload protective features, and protective devices to assure proper sequence of operation, it also includes the electronic detection of fault as distinguished from the high charging current encountered when the equipment is started. In event of a fault, the equipment will reduce the primary voltage to give time for the fault to clear, and will then reclose a number of times before shutting down. It will also detect failure of the KC-4 tube and remove the high-voltage power.

Industrial Precipitators . . . *Small Power Pack*

A small, compact, electronic rectifier for industrial-type electrostatic precipitation applications consists of two parts: one, a half-wave rectifier rated 9500 volts rms, 5 ma, consisting of the transformer tube and socket; the other, a control panel with indicating light, ON-OFF toggle switch, overload protection, short-circuit light, and a resonant circuit which produces a constant-current output. The unusual constant-current feature assures the holding of voltage across the collector plates near the arc-over voltage, thereby greatly increasing the collecting efficiency regardless of the accumulation of dirt on the collector plates. Each power pack will supply power for collectors rated 15,000 cu ft per min.

CONSTRUCTION

Soil Compacting . . . *With Vibration and Water*

VIBROFLOTATION, employing an electric vibrator and water for compacting soil, was experimented with during the year by the Bureau of Reclamation at Enders (Nebr.), and was used in compacting the foundation for new kilns on the east coast. The inventor and owner of the machine has successfully drilled about 170 holes, and has proved Vibroflotation an economical and expeditious means of compacting sandy and gravel soils.

Electricity controls the process, pumps the water, and drives the vibrator by flexible cable throughout the length of its vertical travel. The totally enclosed 30-hp 900-rpm motor in the operating head has bearings of revolutionary design to withstand the continuous vibration.

Jeep Generator . . . *For Power in Field*

A mobile generating unit particularly for operation of machine tools, floodlights on construction work, and servicing remote from power lines is being produced by Farnsworth and Middlekauff, Toledo, designers and builders of specialized equipment for Willys-Overland Jeeps and Trucks. Either a 3.75-kva or 12.5-kva 3-phase 4-wire generator is used, operated at 1800 rpm, and generating at 120 to 208 volts, 60 cycles.

WATER SUPPLY

Cincinnati . . . *Doubling Its Available*

CINCINNATI'S present steam-driven water system, with a capacity of 153,000,000 gal daily, will be supplemented by new equipment capable of adding 145,000,000 gal per day to the system. In the new Tennyson Avenue Pumping Station, costing more than one million dollars, there will be two 3000-hp synchronous motors, each driving a pump capable of delivering 25,000,000 gal daily at 220 psi pressure. Each of three 1250-hp synchronous motors will drive a 25,000,000-gal pump at 90 psi pressure and one 2500-hp wound-rotor motor will drive a 20,000,000-gal pump.

Louisville . . . *Replacing Steam*

Louisville (Ky.) is replacing its steam-driven equipment with a new electrically driven system capable of handling 60,000,000 gal daily. At the Riverside station, the largest of the six synchronous motors will be of 2500 hp, to pump the 60,000,000 gal directly from the Ohio River to the water-treatment station 1¼ miles away. A 1750-hp and a 1500-hp motor and three 1250-hp motors will be used in the treatment station. Their pumps will relay water to the residents, or pump it 14 miles farther to a booster pump feeding the Cardinal Hill Reservoir.

Liquid-level Control . . . *And Turbidity*

The effect of a change in temperature is the secret behind the operation of a Thermolevel device for controlling level in water and sewage plants—or where other liquids and such flowing materials as grain, sand, and chemicals are handled. The device requires no maintenance and it is inexpensive, fireproof, explosion-proof, and reliable.

A turbidimeter was developed for automatically recording the turbidity of liquids, especially in city water supply and sewage-treatment plants, and also for chemical and beverage plants. It can be used at various places in the treatment process and on the final effluent to record parts per million of solids in the liquid, independent of color.

CRANES—BRIDGES—DREDGES

Hunter's Point Crane . . . *Biggest in World*

TWO enormous cranes operating on one runway were installed at the U. S. Naval Dry Docks, Hunter's Point, San Francisco. Built by the Alliance Machine Company, and erected by American Bridge Co., they are the largest in the world and they have many novel features. The cranes, with 142-ft span and side girders 22 ft deep, are on a 730-ft runway spanning a pier of 405-ft width. The runway's fixed cantilever arms reach 162½ ft over the water on each side of the pier.

Each crane is equipped with a single trolley carrying a main hook and an auxiliary hook. The main hook has a rated capacity of 250 short tons at 10-fpm hoisting speed, and the auxiliary hook 55 short tons at 30-fpm. For loads in excess of 250 tons, the cranes are coupled for tandem operation, functioning as a single crane for bridge propulsion. An equalizer beam with a giant double-barbed swivel hook in its center is suspended from the two main hooks, giving a combined rated hoist capacity of 500 short tons at 10 fpm.

Locomotive Cranes . . . *Electrically Propelled*

Locomotive cranes have many uses on yard tracks in and around steel mills; heavy machinery manufacturing plants; open-pit mines and construction jobs in handling miscellaneous hoisting jobs; lifting scrap iron and steel with a magnet; and handling bulk material ch as ore, coal, sand, gravel, or crushed rock with a ıb bucket. Being mobile, they also double as a switch gine capable of 15 mph when handling several ndard railway freight cars.

As size of cranes increased, space for the multiplicity gearing and universal joints for the travel drive came increasingly difficult to handle. The problem s solved by coupling a generator to the diesel engine d propelling the locomotive crane with an electric otor supported from each of the two trucks.

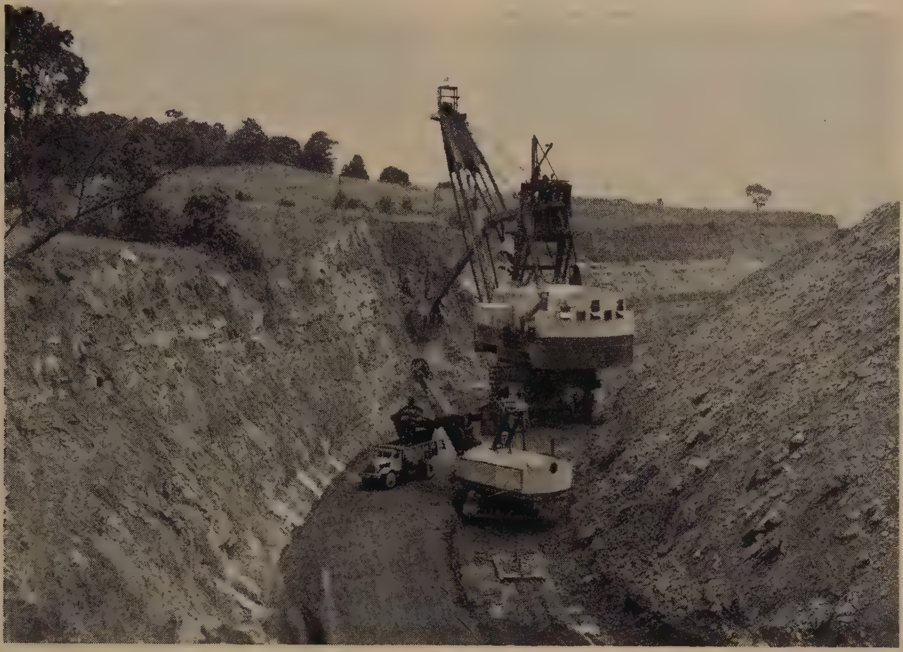


Fig. 29. World's largest open-pit mining equipment in action. Machines of this type are one reason why their coal production is so efficient

dge Control . . . *Another Amplidyne Job*

The newest Passaic River vertical-lift bridge em-dies a new system of control. The movable span is 2 ft long and 88 ft wide, weighs 2,570,000 lb, and is unterweighted by about the same weight; it is raised d lowered by cable sheaves at the tops of towers at ch end of the span. Raising the span 100 ft requires 5 sec, and gives a clear opening of 135 ft for navi-tion.

It is essential that the span be maintained in align-ent while being raised or lowered. Some shortcomings the previous power-selsyn drive have been largely ercome by the new system which, in addition, pro-les a greatly refined speed-torque control—so im-rtant in bringing such a large structure down on its t. The new system has an amplidyne-controlled justable-voltage direct-current drive in each tower. is control begins to correct span skew if the align-ent is out by one-half inch.

edges . . . *A Clean Schuylkill*

Deposits of sewage and coal silt or culm several years made the Schuylkill unnavigable, and today it is rren of game fish and offers no swimming, according reports. A 75-mile stretch between Port Clinton d Norristown will be dredged as part of Pennsyl-nia's 10-yr program to clean up the state's waterways. Four electrically equipped dredges built by the American Steel Dredge Company will be employed. Power for the electrically operated dredges will be supplied by cables from mobile shore stations.

VEHICULAR TUNNELS

Fluorescent Lighting . . . *Ribbons of Light*

ONE of the features of the Triborough Bridge and Tunnel Authority's new Brooklyn-Battery vehicular tunnel, now under construction, will be its fluorescent lighting.

The four continuous lines of 6-ft T-8 4500-deg white Slimline fluorescent lamps—two in each tube housed in clear Pyrex "pipe" near the top of the tube sidewalls—will make each roadway a ribbon of light approaching daylight in quality and uniformity. Astronomical clocks will switch higher current through the lamps in the portal sections during daylight hours, to reduce contrast when driving from bright sunlight into the tunnel.

The power supply to the lighting system will be so interspersed that partial or complete power loss at one end of the tunnel will not leave any section in darkness.

COAL

Electric Shovels . . . *Big Bites*

A WHOLE railroad carload of earth or rock—60 tons or more—scooped up and deposited in less than a minute at a distance of some 200 ft and 75 ft high characterizes the ability of electric shovels put into operation (Fig. 29) during 1948 at open-pit coal mines in Illinois. The two Marion shovels equipped with General Electric adjustable-voltage amplidyne control include one for the Southwestern Illinois Coal Corporation at Percy and the other for the Midland Electric Coal Corporation, Sheffield. They are 40 cu yd equipments, the largest heavy-duty open-pit mining equipment in operation anywhere—duplicating essentially a similar machine put into operation in 1947 by the Hanna Coal Company at Georgetown (Ohio).

Preparation Plant . . . *Automatic*

There's a wide variety of electric equipment in a plant completed during the year for cleaning and blending 2000 tons of coal per hour. An outstanding feature of the control equipment is the automatic control for the loading of the raw coal and blending bins. It is so arranged that a shuttle conveyor moves automatically over a bin, fills it, and automatically moves on to the next. More than 300 motors, from ½ to 300 hp in size, are used in handling, cleaning, blending, and loading the coal. Fourteen sections of Cabinetrol are located throughout the plant, with individual capacitor banks on each section for power-factor correction.

ROCK PRODUCTS

Two Cement Plants . . . *And a Problem*

CEMENT production in this country received a much needed boost of 2½ million barrels yearly when two new plants were placed in operation during the year by the Ideal Cement Company. One (FIG. 30) is at Portland (Colorado) and the other at Devil's Slide (Utah). Only two years elapsed between ground-breaking and full-scale operation. In this industry no other plants replace man-hours with kilowatt-hours so extensively.

How to start 1000-hp synchronous motors driving tubular ball mills from power sources of limited local capabilities was a difficult problem. It was solved with motors of high torque efficiency, especially designed to start and accelerate the large cement ball mills without undue disturbance to the power system.

PETROLEUM

Bit-weight Control . . . *It's Automatic*

ANY preset bit weight is held accurately and automatically by an electric system which can be applied to any kind of rotary drilling—electric, mechanical, or steam. It simplifies the driller's job, and contributes to straighter holes, increased bit life, and uniform maximum drilling speed. Major components of the system are a 15-hp drag generator, an amplidyne-controlled regulating generator and exciter, the main control panel, and the driller's controller.

Manual control of a brake on the draw works was a full-time job demanding close attention. With the new control, the driller merely sets two knobs; thence the system automatically holds the preselected bit-weight, independent of drilling speed. The drag generator applies the electrical hold-back torque to the draw-works drum. The amplidyne-controlled regulating generator keeps this torque constant over the selected range of drilling speeds.

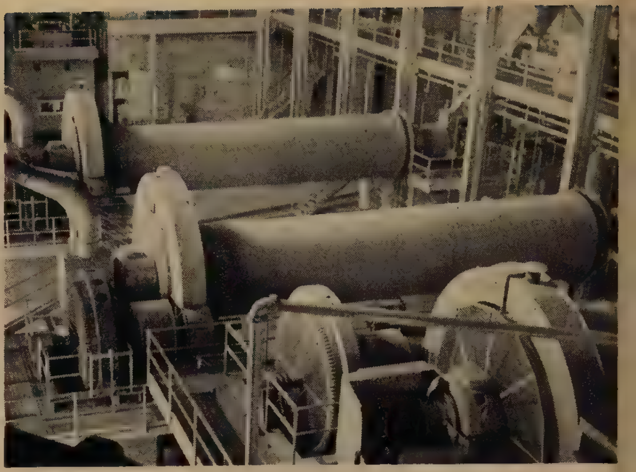


Fig. 30. A 500-hp synchronous motor (foreground) driving a ball mill at Ideal Cement Company plant at Portland (Colorado); two 1000-hp synchronous motors (beyond) drive compartment mills

Drilling Rigs . . . *Completely Electri*

Typical of completely electrified oil-well drilling rigs installed during the year were three equipments put into operation in the southwest oil fields. Each includes one or more 400-kw 900-rpm 600/450-volt diesel-driven generators with V-belt-driven exciters. A number of rigs were partially electrified. A 150-kw generator with similar characteristics was used in several instances.

LUMBER

Log-carriage Drive . . . *10,000 Ft Mor*

FIVE amplidyne-controlled electric log-carriage drives were installed in northwest mills during 1948, and three more were about ready for installation. One of the new equipments, at Glendale (Ore.) has shown a power cost of $3 per day; another mill reported an increase in production of 10,000 ft per day.

PAPER

Sectional Drives . . . *Real Speed Regulation*

SECTIONAL paper-machine drives installed during the year permitted extremely precise speed regulation A paper manufacturing machine is a group of individual machines, connected only by a thin web of paper. The speed of these machines which form, squeeze, dry, finish, and roll the sheet must be held to speed with hairline accuracy to avoid breaking the sheet.

Since the war the speed-regulating job has been accomplished by a special speed regulator using an electronic preamplifier and an amplidyne exciter—the same combination that worked so successfully for many turret control jobs during the war. Over 24 paper machine drives employing these speed regulators are in successful operation.

PRINTING

Color Register . . . *On Plastic*

PHOTOELECTRIC register control of color printin is now an old story, but one of the year's installa tions had a new feature. This type of control is a contin usly regulating equipment which detects position rors and makes rapid corrections. Five colors are being gistered successfully on webs of Cellophane and other astic materials in an installation at Milprint Company, ilwaukee.

ying Paste . . . *Batting Average, 1000*

Fast-running newspapers are not shut down when e end of the roll of paper is approached—a new roll fastened to the old one. A Thy-mo-trol drive was plied to a Wood Newspaper Machinery Company's Autopaster" to match the speed of a new paper roll that of the press preparatory to a flying paste. On roduction in the plant of the *New York Times*, up-ards of a thousand successful pastes have been made ithout a single miss—a new standard of performance.

TEXTILE

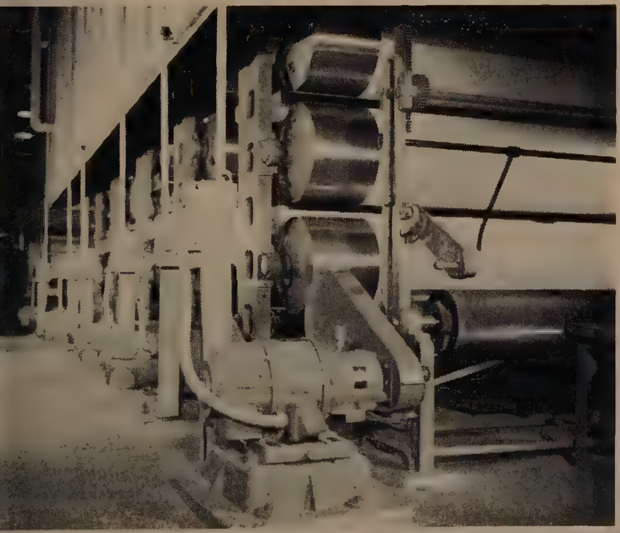
arn Tension . . . *With a Magnet*

WINDERS, twisters, and warping creels require a device to apply and maintain a smooth, constant nsion to delicate yarns. A new magnetic tension device either abrades nor flexes the yarn, and it holds tension latively constant despite wide changes in linear speed.

The design, based on a hysteresis principle, consists a thin lightweight aluminum disk with a grooved lge in which the yarn rides, an annular alnico ring ounted in the disk, a sealed ball bearing on which e disk rotates, a horseshoe alnico magnet fixed to a readed mounting pin, a calibrated magnetic shorting ar for setting tension, and a plastic dust cover.

ariable Speed Spinning . . . *25 Percent Gain*

In variable-speed spinning, the speed of the textile inning frames is continually varied to hold yarn nsion uniform. A type of brush-shifting adjust-ble-speed motor has been applied to several installa-ons, totalling more than 200 such motors. Tests show roduction gains of from 12 to 25 percent, with accompanying improved yarn quality. A major factor in the success of the application is the use of a new tensiometer, which gives a continuous record of yarn tension throughout the "doff."



ig. 31. A completely new textile finishing plant, the largest of its kind n the world

Enclosed in the rectangular housing at the upper right is a 300-hp synchronous motor for use in hazardous locations

Loom Motors . . . *With Flywheel*

A study of the characteristics of loom loads indicated that better efficiency, high power factor, smoother loom operation, and greater production could be obtained by increasing the drive inertia. Hence, a built-in flywheel was developed for a new line of loom motors. The new motors, in ¾, 1, 1½ and 2-hp ratings, 1800 and 1200-rpm design, have a single frame diameter. Cast stator frames replaced the previous riveted frame design, improving the appearance and giving more substantial construction.

Range Drives . . . *Largest Yet*

A completely new finishing plant, reportedly the largest of its kind in the world, has 16 range drives. Over 150 motors and gearmotors are used. The d-c adjustable-voltage system gives smooth, easy control of the cloth speed. The mill (Fig. 31) includes ranges of all types, from bleaching, mercerizing, and washing to plain finishing or dyeing. Altogether, some 50 range drives, totalling several hundred motors and gearmotors, were installed or under construction during the year.

Rayon . . . *10,000,000 Lb Yearly*

A new rayon plant, which will produce 10,000,000 lb of yarn annually, will involve 60 spinning machines. The required electric equipment includes switchgear, high-frequency generating equipment and distribution system; and some 8000 rayon spinning motors and buckets, as well as a considerable number of motors ranging from 5 to 800 hp for general plant machinery and equipment.

To fill the need for a motor large enough to drive 12-in. buckets, an autodamped rayon motor was produced with approximately 2½ times the output of the Type KTA-11 at 10,800 rpm. Lower critical speeds, simplified unit assembly, better protection against water and acid, and rapid plugging by use of a Y-delta reconnection characterize this motor.

MACHINE TOOLS

Boring Mills . . . *Contour-following*

SINCE railroad car wheels are sorely needed today, two special boring mills produced by Cincinnati Planer Company are of much interest. Equipped with electronic contouring equipment, they are producing car wheels in reduced production time, and with finer finish and greater accuracy. The equipments were built for the Armco Steel Corporation's Butler (Pa.) Division.

The 100-hp main-drive motor provides table speeds of 5 to 25 rpm. Seven electronically controlled 1-hp feed motors are used for contouring. Operation is fully automatic after the "start" button is pressed. The rail heads, with simple straight-line movement, are controlled by limit switches. The more complex motions of the side heads are controlled by the automatic tracer head moving along the template, and by an auxiliary set of limit switches when the tracer is not in contact with the template. After the cuts are completed, and all tools retracted to the starting point, the machine stops, ready for reloading.

RUBBER AND PLASTICS

TENSIOMETERS, so successfully applied in the steel industry, were introduced into the rubber industry with the application of two equipments (FIG. 32) for measuring tire fabric tension in the treating and calendering process. Two 400-hp 100-yd per min high-accuracy plastic calenders installed during the year are the largest and fastest yet designed. The main and auxiliary drives are completely electric with electronic control.

STEEL AND METALS

Magnetic Amplifier . . . *A New Tool*

A NEW tool—the magnetic amplifier—emerged from the laboratory to the steel mill. This new device may prove as important to the progress of the steel industry as has the amplidyne.

The magnetic amplifier has no moving parts or filaments. Its principle of operation is based on the principle of the d-c saturable reactor wherein a small input signal can be used to control a relatively large output signal. Under proper conditions, the amplification and speed of response are comparable to that of the amplidyne.

Although available at present for only a few applications and relatively low outputs, the magnetic amplifier will probably take the place of the amplidyne or the electronic amplifier in some regulating circuits but wil be applied in conjunction with the amplidyne in man others.

Hot-strip Mills . . . *New Use for Rectifier*

Existing hot-strip mills are being revamped and new mills of both the continuous and reversing type ar being built. On the West Coast, the first fully integrate steel plant in that area will undergo another expansion An existing plate mill will serve as a rougher for fou new 86-in. continuous finishing stands. Two mercury arc rectifiers, each rated 5000 kw, 600 volts, will supply power to the finishing-train motors. These rectifiers wil be used to start the mill motors from rest by phase retard. This will be the first time that rectifiers alone have been used in this country for full adjustable voltage control of a continuous hot-strip mill.

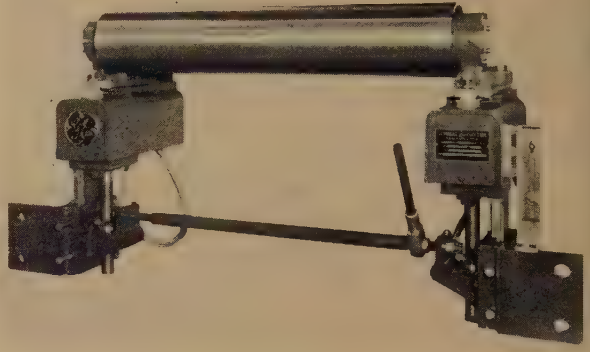


Fig. 32. For measuring the tension in tire fabric during the treating and calendering process

Tandem Cold-strip Mills . . . *Into Productio*

Four of the five tandem cold-strip mills with individual generators (mentioned last year) have now gone into production. The first, the world's fastest 5-stand mill (FIG. 33) has operated as high as 6250 fpm and has turned out over 2140 tons of tinplate in one 24-hr period. The others—a 93-in. 3-stand sheet mill, a 54-in. 4-stand sheet mill, and a 56-in. 5-stand sheet and tinplate mill—have proved that individual generators are far superior to the common-bus scheme fo modern high-speed mills. The fifth, a 40-in. 5-stand tinplate mill, will go into operation this winter.

Reversing Cold-strip Mills . . . *On the Wa*

Some of the largest reversing cold-strip mills eve designed are now being built. Two such 66-in. mills wil be installed in Luxembourg. Each mill will be of the conventional four-high type. The synchronous m-g set for each mill will consist of one 2000-kw 600-volt main generator and two 640-kw 600-volt reel generators Amplidyne control of voltage and tension will b provided.

Temper-pass Mills . . . *Almost as Fas*

In keeping with developments in other cold-rolling mills, temper-pass mills are becoming larger and faster

At the present time a 42-in. 5000-fpm two-stand mill is being built which will nearly match the output speed of the fastest tandem cold-reduction mills.

Pickling, Cleaning, and Scrubbing . . . *No Dancer Roll*

A new 66-in. high-speed pickling line has a rated speed of 500 fpm through the pickle tanks and 800 fpm on the entry and delivery ends. Independent generators are used for the entry, pickling, and delivery sections with amplidyne control of generator fields for fast starting and stopping. In the absence of the conventional dancer roll in the pickle tank, a magnetic loop position regulator was used. This consists of a magnetic detector unit encased in an acid-proof cover and located in the bottom of an acid-filled tank. The output signal, which is governed by the position of the steel strip in the tank, is fed into a magnetic amplifier which, in turn, controls the speed of the entry pinch roll through a booster generator.

Drawbenches . . . *No Return Drive*

Several large installations of drawbenches were completed and placed in operation. The largest involved seventeen drawbenches of various types. Work is now progressing on several of the reversing-chain drawbenches, which eliminates the carriage-return drive. MD-600 series mill auxiliary motors are used to drive these reversing-chain drawbenches. Seven benches of this type were recently ordered by one nonferrous producer.

nduction Heating . . . *Successful*

Frequencies obtainable from rotating machines are being used for the induction heating of steel strip. Several successful applications have been made and many more are being considered.

A 54-in. heavy-gage continuous-strip galvanizing ine is using two 700-kw 9600-cycle alternators to supply power for heating the strip to approximately 1350 F.

One of the fastest existing electro-tinning lines has been given even greater capacity for some classes of product by the addition of 300 kw of 9600-cycle induction heating for flow brightening. The inductor coil has been added ahead of the existing electronic induction heating equipment. Two 9600-cycle 150-kw 3600-rpm nductor alternators are used as a source of power. Similar equipment will be installed on another electrotinning line, and 600 kw at 9600 cycles will be used for preheating the strip in the manner just described.

lectric Hot-topping . . . *New Development*

One of the new developments in steel making is the ot-topping of alloy ingots with an electric arc. Each ngot is heated separately with a nonconsumable lectrode connected to a welding m-g set. The electrode s automatically positioned by a small d-c motor and a voltage regulator of the amplidyne or electronic types. Work is progressing on a magnetic amplifier for this ame purpose—it will require no electronic tubes or otating parts.

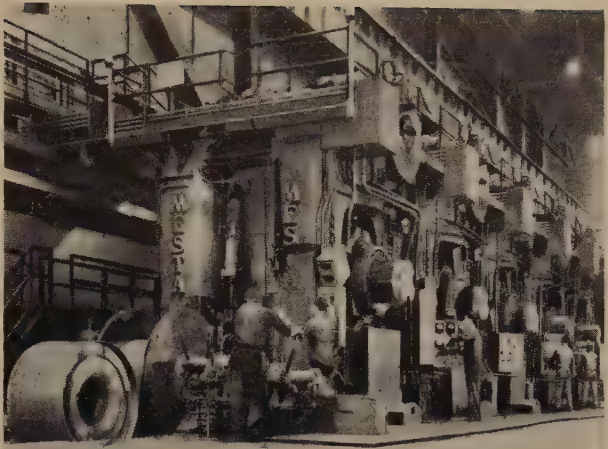


Fig. 33. This mill, the world's fastest five-stand mill, has a speed as high as 6250 fpm, and it has turned out as much as 2140 tons of tinplate in 24 hr

FARM INDUSTRY

Portable Motor . . . *Easy to Use*

A NEW 5-hp single-phase portable farm motor has been made available. Complete with truck, starter, cable, receptacle, and plug, it can be used for a wide variety of jobs, saving farmers the expense of buying several motors. The motor is easy to use and install.

Crop Drier . . . *Hay or Grain*

A developmental equipment for drying crops (FIG. 34) was built for the U. S. Department of Agriculture for such a wide variety of crops as ear corn, small grains of all kinds, peanuts, cotton seed, rice, hay, and similar forages. Its capacity is as high as 12,000 cu ft of air per minute and as high as 750,000 Btu per hr.

Water-pump Switch . . . *Quiet*

A new pressure switch for domestic and farm water systems operates quietly and, it is indicated, has exceptionally long life. It can be used with motors rated up to 1 hp at 115 or 230 volts a-c, and up to ¼ hp at 230 volts d-c, with pumps having pressure ranges from 26 to 60 lb.

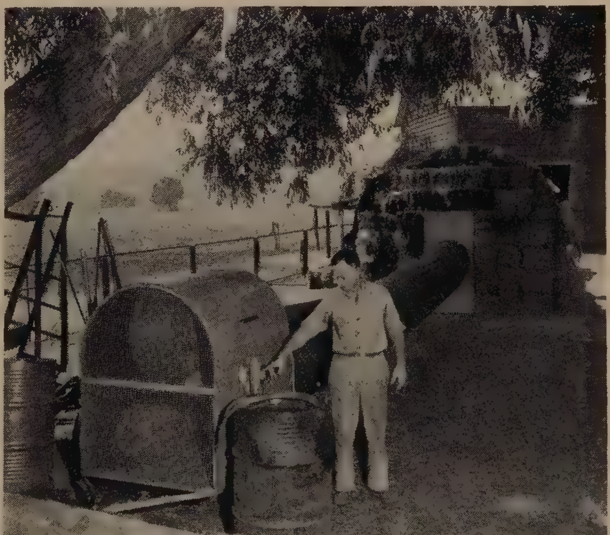


Fig. 34. A crop drier, shown here curing hay, can be used for a wide variety of crops

The SS *President Cleveland* on her trial run, shown leaving San Francisco Bay. Construction of main-propulsion units and electrical installations for several ships of this class began during the year

TRANSPORTATION

• • • • • • • •

AVIATION

Propulsion . . . *Nearly 671 Mph*

HUGE crowds attending the National Air Races at Cleveland, September 5, saw Air Force Major Dick Johnson flash over the General Electric three-kilometer course at 670 mph in a North American F-86 swept-wing fighter plane powered by one of the year's new turbo-jet engines, General Electric's TG-190. Ten days later, the same ship set an official world speed record of 670.981 mph. Recognized as the most powerful engine of this type in production in 1948, the 5000-lb-thrust TG-190 was turned out in quantity at Lynn. Since expansion to the limit of production facilities at Lynn and Everett (Mass.) could not meet the demand, a 700,000-sq-ft plant at Lockland (Ohio) was leased to increase production. The Lockland plant will be able to produce about twice as many engines as the Lynn plant, but will manufacture no parts for the engines, this work being handled by other companies on a sub-contract basis.

The Wasp Major-VDT engine was another of the year's prominent developments. The outcome of collaboration between Pratt & Whitney and General Electric, this new and revolutionary piston-jet propulsion combination consists of a 28-cylinder P&W Wasp Major engine and a two-stage G-E variable-discharge turbosupercharger with General Electric automatic controls. The VDT engine increases the output of the Wasp Major from 3500 to more than 4300 hp, at the same time improving fuel consumption, range, and other performance characteristics.

Several of the new TG-100B turboprops were completed during the year, some having been assigned to General Electric by the Air Force for a test program to evaluate performance, mechanical operation, and control characteristics.

In the development of a satisfactory control for turboprops, a problem which has been attacked vigorously both in this country and in England, one of the outstanding systems is the "torque control" design incorporated in the TG-100B.

Boeing's Stratocruiser, the newest commercial airliner (FIG. 35), passed successfully its CAA type-certification tests in September. This outstanding passenger plane is equipped with G-E turbosuperchargers and electric generating system.

A new aircraft gas-turbine research laboratory in Lynn was in partial operation through 1948, providing data which contributed to the TG-190 production program. The laboratory includes three basic elements, each devoted exclusively to evaluating the performance of one of the major jet-engine components: compressor, combustion system, and turbine.

Radiosonde . . . *Continuous Automatic*

Future radiosonde ground stations will include receiving-type, direction-finding equipment for automatically tracking the flight of a balloon-borne transmitter sent aloft for useful meteorological information. Continuous records provide printed data for determining wind velocity and direction, and indications of temperature, relative humidity, pressure, and cloud height.

The lightweight, two-axis antenna assembly, and other components designed for the Signal Corps, can be packed and transported in a standard, one-ton cargo trailer. The equipment for the Bureau of Ships comprises a sturdy, three-axis antenna assembly and a remote-control console designed for either shipboard or shore installation.

Armament . . . *B-36, B-50*

Deliveries to the Air Force were started on armaments for the world's largest bomber, the Consolidated-Vultee B-36. These systems are composed of several power-driven gun turrets, with their associated control, together with optical and radar sighting stations and automatic computers for lead and ballistic corrections.

Designs were completed and production started on several models of gun turrets and armament-system control for the B-50. Surplus B-29 armament was being modernized with modification kits.

Electric Components . . . *Selsyns Smaller*

The aircraft selsyn of which approximately 800,000 were built during the war, was redesigned (FIG. 36), at approximately half the former size and weight, with no impairment in performance. For two-speed selsyn systems, two units are permanently geared together and properly zeroed as one tandem selsyn unit, only slightly longer and heavier than one old-design selsyn.

A 50-hp hydraulic transmission with adjustable speed ratio was put in production. Used in conjunction with

00-rpm, 400-cycle, 115-volt alternators, the drives re governed to provide constant speed and so permit aralleling alternators driven from separate aircraft igines.

A 28-volt d-c generator-control system was developed, ith drawout panels for easy maintenance and compact istallation, to provide complete protection of the gen- ator electrical system.

(*Boeing photo*)

Fig. 35. The Boeing Stratocruiser is equipped with G-E turbosuperchargers

Extremely close frequency control (±0.5 percent) ; a feature of a new 5-kw 120-volt d-c (input) inverter. Development of a complete line of 120-volt d-c equip- ient, to handle the increased demand of larger gener- ting systems than can be handled by direct current f lower voltage, was a major program. Thus 30-kw enerators with switchgear and control were devel- ped, as was a series of high-current line contactors.

Electronics have a part in the control for the new 'ratt & Whitney Wasp Major-VDT engine previously escribed.

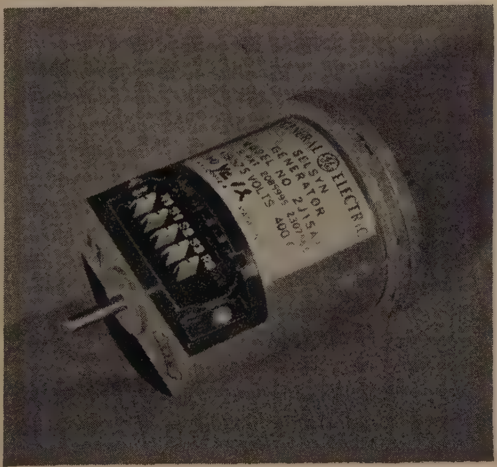


Fig. 36. Today's selsyn for aircraft is about half the size and weight of World War II units

Propeller-control switches, redesigned to work with new propeller, incorporate twice as many functions, ith a resultant improvement in aircraft safety.

Remotely positioned searchlights for Naval aircraft feature smaller diameter, lighter weight, and increased-beam candlepower.

All-electric autopilots were developed and delivered for evaluation.

Ignition Systems . . . *Manna from Heaven*

Advances in aircraft engine design have made mandatory an ignition system capable of performance better than that of the existing high-voltage system. A high-frequency low-voltage ignition system designed for the Pratt and Whitney R-2800 engine promises, from all indications, to be the "manna from heaven" sought by aircraft operators. The system (Fig. 37) consists of a dual magneto, two low-tension distributors, an ignition shielding assembly, and 36 spark plugs. The a-c voltage impulses are rectified by midget selenium rectifiers and stored in capacitors in a simple voltage-doubler circuit. The capacitors are charged by the magneto to approximately 3200 volts, and discharged at high-frequency by the distributor. Built-in transformers step up the system to approximately 18,000 volts peak to fire the spark plugs. The system has CAA approval. An ignition system of this type was also developed for the new Pratt & Whitney R-4360 VDT engine, making possible considerable weight saving.

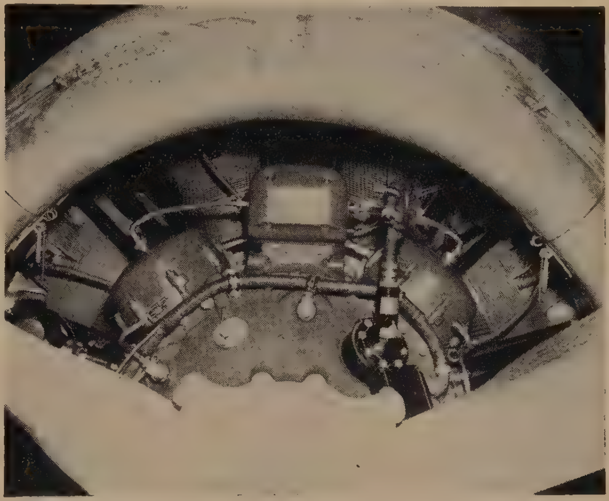


Fig. 37. High-frequency low-tension ignition system in use with a Pratt and Whitney R-2800C engine in the nacelle of a Convair 240

Aviation Radio . . . *Several Channels*

A new equipment supplementing the line of personal-plane Flying Radiophones permits reception of navigation, control-tower, and broadcast signals, and also enables the pilot to talk to the ground over a choice of several very high frequency (122-megacycle) channels.

MARINE

Large Tankers . . . *Turbine-gear Drive*

Propulsion turbines or gears for more than one-third of the 50 large oil tankers under construction or contract during the year will be supplied by General Electric. Nineteen fast, long-range tankers will be so equipped; thirteen with turbines and six with gears.

Nine of the turbines will each deliver 12,500 shaft-hp at 112 rpm; maximum continuous operation can be as high as 13,750 shaft-hp. Rated steam conditions are 835 lb gage at 840 F at the turbine with 28½-in. vacuum. This combined steam pressure and temperature is the highest ever used in merchant ships.

Among the ships delivered with the main-propulsion units were five large cargo carriers, now in service between North and South America; the 16,000-hp *Bulkpetrol*, world's largest tanker; and the SS *President Wilson*, whose construction was shelved during the war. Several yet to be delivered are for the American President Lines and the American Export Lines; three are in the 16,000-hp class for various tanker lines.

Almost the entire electrical installation, as well as the main-propulsion units, will be built by G.E. for the three world-cruising President Liners. The 12,500-hp geared-turbine drives for these ships will be similar to those installed in the new long-range tankers.

Numerous idle tankers were recommissioned during the year because of the world-wide oil shortage. Service engineers and service-shop personnel were sent to shipyards all over the country to supervise the reconditioning of tankers' propulsion equipment.

The single-screw *Alaska Standard* was stepped up in both speed and power by modification of its propulsion armatures during its first major overhaul after 24 years of supplying southeastern Alaskan ports and canneries with petroleum products. The 210-ft diesel-electric-driven "floating service station," one of the best known and most popular ships in Alaskan waters, has been keeping families and industries of the area in heat, light, and power since its commissioning in 1923.

Boom Conveyor . . . *World's Largest*

One of the fastest self-unloading systems yet devised, including the world's largest shipboard boom conveyor, was installed on the Great Lakes vessel SS *Crispin Oglebay* by the American Shipbuilding Company. The new all-electric conveying system is powered by approximately 750 hp in induction motors. Normal unloading speed of 1800 long tons per hour for ships of this type has been increased on the *Oglebay* to 2200, and the installation is capable of still higher unloading speed, discharging cargo 230 to 235 ft from the ship.

Weight of the 240-ft alloy-steel conveyor boom (FIG. 38) was reduced 10 percent by making it all-welded. For hoisting and supporting the boom there is an A-frame rising 52 ft above it near the bow, continuing to the hull and framing on the sides and bottom. The apex of the A-frame is fitted with a swivel for free movement of the upper end of the boom, which can be swung 113 deg each side of the centerline, and can be inclined up to 30 deg from horizontal, although recommended maximum inclination is 18 deg.

Marine Communication . . . *Self-contained*

A compact, self-contained, 5-watt radio-telephone equipment was designed particularly for yachts, providing ship-to-shore, ship-to-ship, and emergency (Coast Guard) frequencies at the touch of a switch. Its operation is simple, requiring only the lifting of a telephone handset and a turn of the volume control. The "top-loaded" antenna, of telescopic aluminum tubing, is 18 ft long but acts electrically as though it were a 50-ft wire antenna, thus providing increased performance of the radio-telephone.

Since existing AM channels are badly overcrowded in the marine bands, there has been a trend toward the use of FM, which will reduce "jam" and permit static-free communication. Modified taxi-station equipments in the 152-162 megacycle band were installed on several tugboats, ferryboats, and a Great Lakes ore carrier. Results were extremely encouraging, particularly from the users' viewpoint.

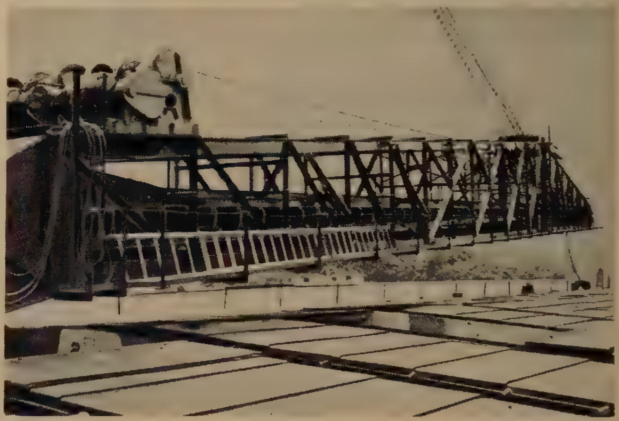


Fig. 38. The world's largest boom conveyor, aboard the S.S. *Crispin Oglebay*, driven by a 300-hp motor

LAND TRANSPORTATION

Gas Turbine . . . *The Railroads Watch*

MORE than 50 railroad officials and technical experts watched a demonstration of the railroad gas-turbine power plant in March. They inspected the 19-ft-long 20,000-lb power plant, built to fit in a single-unit locomotive. The power plant is rated 4800 hp when running at 6700 rpm with a 1400-F turbine-inlet temperature.

The characteristic straight-through in-line design of compressor, combustion chambers, and turbine was selected particularly for railroad application. This simple arrangement is particularly desirable in a power plant designed for long life and heavy fuels.

Since the time of the demonstration, the gas-turbine power plant has been installed in an experimental Alco-G.E. 4500-hp locomotive which is undergoing track tests (FIG. 1, p. 11).

Motor-generator Locomotives . . . *Biggest Yet*

Four 6800-hp two-cab motor-generator-type locomotives were shipped to the Virginian Railway. Largest of their type in the world, these 11,000-volt single-phase 25-cycle electric locomotives, each more than

0 ft long, are the first to have a million pounds on ivers. Designed for heavy-grade, heavy-haulage ountain operation, they have regenerative braking, d each of the 16 axles is motor-driven. Rated tractive ort is 162,000 lb at a speed of 15.75 mph and 16.2 rcent adhesion. For starting and acceleration, tractive orts up to 260,000 lb are possible.

eavy Suburban Service . . . *New M-u Car Equipment*

New arrangements of apparatus for the propulsion multiple-unit cars in heavy suburban operation were lopted by two of the nation's largest operators. New ork Central System purchased 100 cars using four the new truck-mounted motors especially developed r heavy-duty rapid-transit service; and the Pennsylnia Railroad has ordered 53 equipments employing ur self-ventilated motors, truck-mounted on rubber shion supports, instead of the conventional axle-ing force-ventilated two-motor equipments.

esel-alternator . . . *Self-sufficient*

Twenty-five-kilowatt diesel-alternator under-car ower plants, under test on several railroads, make ch car completely independent of locomotive power r lights, air conditioning, and other passenger-car quirements.

esel-electric Locomotives . . . *New and Improved*

General Electric's five standard industrial-type esel-electric switching locomotives—25, 45, 50, 65, d 80 tons—were augmented by the addition of a w model, the 90-tonner. This 660-hp four-axle itcher, with a maximum speed of 25 mph, has a ntinuous tractive-effort rating of 30,400 lb, and erefore has large pulling power at low speeds for a nsiderable period of time without overheating.

Improved designs of the 65- and 80-ton switchers ere made; the changes in the units give increased wer and improved continuous tractive-effort ratings IG. 39). The new locomotives are each equipped with o supercharged diesel engines with a maximum ratg of 275 hp at 2100 rpm, or a total of 550 hp per comotive. Because of the duplication of equipment the two models, both the 65- and 80-tonners can be ed in the same plant without adding to maintenance oblems or increasing the inventory of spare parts.

Construction was started on an order for six 120-n road diesel-electrics for the United Fruit Company, hich will be used for hauling bananas in Guatemala. hese locomotives have very low axle loading and are ilt to operate on light rail and sharp curves.

Construction started on 35 two-cab diesel-electric comotives for the Argentine State Railway. The 170-n 1800-hp locomotives will be 95 ft 4 in. long, 12 ft 8 in. gh, and 10 ft 2 in. wide, each driven by eight traction otors.

During the year, the New Haven Railroad cometely diesel-electrified its Maybrook freight route th Alco-G.E. 4500-hp three-unit locomotives. The diesel-electrics replaced 50 steamers and already are blazing the trail to more efficient and economical operations.

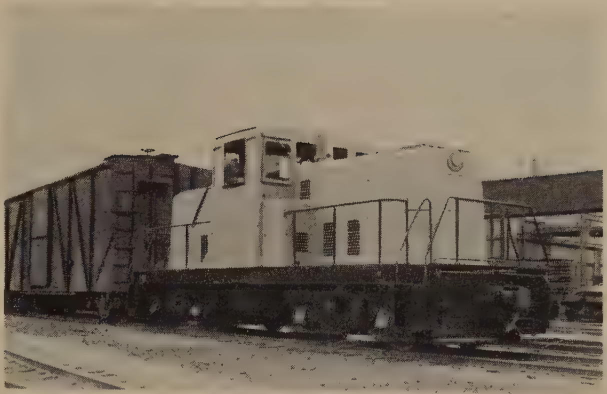


Fig. 39. A 65-ton industrial-type diesel-electric switching locomotive

Urban Transit . . . *More Trolley Coaches*

Trolley-coach expansion during the year was a notable development. Many cities increased their trolley-coach operations; approximately 1040 G-E equipped coaches were shipped during the year.

Shipment was started by car builders on New York's order for 750 large subway cars, half of which will be G-E equipped (Fig. 40). The four motors per car—one for each axle—are used for service braking as well as propulsion. The new, fully automatic, series-parallel control has 20 steps for smooth acceleration and 20 steps for smooth braking with any passenger load.

Carrier Current . . . *Hump-yards and Tugboats*

Early in the year, several installations of railroad communications involving hump-yards, tugboats, and main lines were successfully completed. Such systems provide communication end-to-end, train-to-train, and wayside-to-train for main lines and from a fixed point to locomotives and freight yards. The yard communication, the end-to-end, and the wayside-to-train communication on one important installation use as a transmission medium carrier-current signals induced on the wayside line wires.

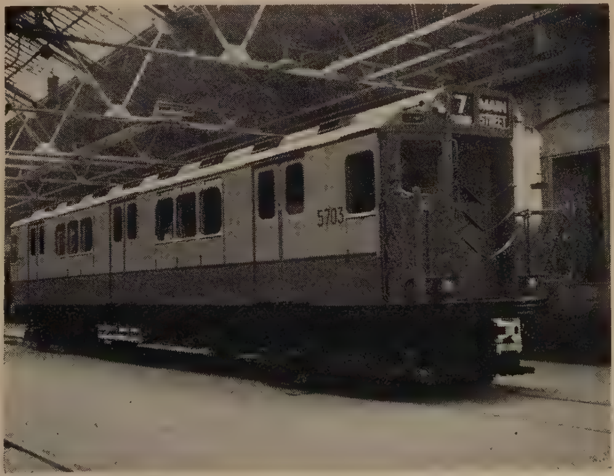


Fig. 40. Postwar subway car for New York's IRT Division. This is the forerunner of 750 large cars ordered by the city Board of Transportation

The Cardioscribe, a new direct-writing electrocardiograph, by eliminating the necessity for film developing, permits immediate examination of the heart-action record

ELECTROMEDICAL

Cineradiography . . . *X-ray Movies*

CINERADIOGRAPHY, more popularly known as "x-ray movies," was given a major boost during the year by special x-ray equipment supplied to independent research scientists at the medical schools of the University of Rochester and the University of California, Los Angeles. The new equipment, exhibited at the 1948 convention of the Radiological Society of North America, in San Francisco, synchronizes the camera shutter with the x-ray generator and employs sensitive recording media, thereby exposing the patient to no more radiation than he would receive in an ordinary spinal radiograph. Among views profiting from cineradiography are the swallowing reflex, digestion, complete chest studies, prostheses, general limb function, and the flow of contrast media through the blood vessels.

Diagnostic Equipment . . . *Mechanized Operation*

A new diagnostic x-ray equipment has mechanized numerous operations hitherto requiring physician's or technician's attention. Termed "virtually a robot," it incorporates automatic determination of exposure time by means of a photoelectric phototimer, and an automatic feature adding greatly to the protection of physician and patient from stray radiation during fluoroscopy. Centering of exposure areas with relation to the primary x-ray beam during spot-film work is also mechanized, thus preventing off-center radiography. Operation at 130 kv, instead of the usual 100 kv, provides wider latitude, clearer radiographs of dense portions of the body, and shorter exposure time, with consequent gain in tube life and in protection from excess radiation. A 60-in. distance from focal spot to table top is permitted by the extremely high radiographic tube stand. Phosphorescent "eyes" in the table help orient physician, patient, and table during the darkness required for fluoroscopy.

Miniature-film x-ray equipment (using either 70-mm or 4×5-in. film) went into hospitals for a new type of anti-TB program—the routine x-raying of chests (FIG. 41) of all hospital admissions.

High-voltage Therapy . . . *2,000,000 Volts*

A 2,000,000-volt x-ray machine was developed specifically for therapy of deep cancer. Two were in process of manufacture—one for the Francis Delafield Hospital, now under construction in New York City, and the other for the Hospital for Joint Diseases, also there. High voltage and high penetration make it possible to confine the beam more closely to the area being treated and allow reduction in treatment time, as well as providing a more lethal dose of x-rays.

Inductothermy . . *More Flexible*

A new, smaller, lower-cost Inductotherm incorporates more flexible, contour-following cable applicators so that body parts of any shape can be treated more efficiently. It also features greater mobility, simpler controls, and a built-in timing mechanism.

Citation, famous race horse, suffered a hip injury last season. An Inductotherm with special large attachments was rushed to his trainer at Arlington Park (Ill.), and deep-heat treatments put him back in the running.

Cardioscribe . . . *And Uv Lamp*

The Cardioscribe is a direct-writing electrocardiograph which makes it unnecessary for the physician to develop a film before viewing the heart's action. Electrically reflected heart rhythms are recorded directly on paper, where they may be viewed immediately.

Weighing 38 lb, the Cardioscribe is self-contained in a portable case. Push-button controls select one of seven leads. The complete unit is composed of three subassemblies, connected electrically and mechanically.

A new ultraviolet fixture for therapeutic applications is more flexible, covers the complete therapeutic spectrum, and is lower in cost.

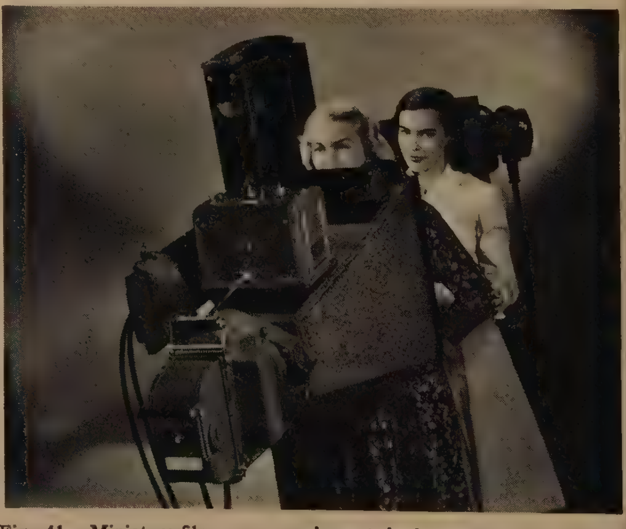


Fig. 41. Miniature-film x-ray equipment is increasingly popular in hospitals for routine chest x-ray of all patients

**utside television programming achieved new speed and effective-
ss with a new mobile equipment. This truck carries complete tech-
cal facilities, including both equipment for field pickup and a relay
oadcasting station**

LECTRONICS

TRANSMITTERS

oadcast . . . *Dish-type Good*

A 10-WATT microwave transmitter, receiver, and directive antenna were developed for studio-
ansmitter link service in order to beam a high-fidelity
und program from main studio to a remotely located
M broadcast transmitter. Use of 40-in. dish-type
etallic reflectors for both transmitter and receiver
itennas gives a large increase in transmitting power
id minimizes interference with other services.

A 10-watt FM broadcast transmitter in the 88-92
egacycle range, utilizing the phasitron modulator,
as designed for low-budget installations in the educa-
onal field.

Adaptability and small space requirements are fea-
ires of new audio amplifiers for FM, AM, and TV.
nly two types are required for all conventional studio
eeds, and are designed for plug-in application to gain
exibility and ease in servicing.

Supplementary units were developed to permit best
e of the high-fidelity characteristics of the variable-
luctance phonograph pickup used for broadcasting.
hese are a transcription arm for the large-diameter
cords, an equalized preamplifier to match the charac-
ristics of the pickup, and an equalizer for use with
isting preamplifiers.

levision . . . *In Three Cabinets*

A new line of television transmitters for low and high
annels with a 5-kw rating combines in three cabinets
e necessary components for both visual and aural
oadcasting, providing radio-frequency shielding and
gh-voltage protection to station personnel. The visual
ansmitter permits low-level plate modulation with linear radio-frequency amplification; the aural transmitter is an FM transmitter employing direct crystal control plus straight-through operation.

Entire operation of the dual transmitter can be monitored from the console position. Its high-quality waveform monitor, which displays the visual modulation envelope with large deflection and good amplitude linearity, allows accurate adjustment of the visual transmitter output in accordance with FCC standards.

For rapid and effective outside television programming a mobile unit was developed which incorporates television field-pickup equipment and a compact relay broadcasting station. Operating accommodations are available for three technical assistants and a program director. Technical facilities consist of three complete camera channels, an audio channel, and associated equipment. All control and monitoring units are shock-mounted.

Police and Utility . . . *Highly Mobile*

For police, fire, forestry, and utility services there was developed a new line of equipment in the 25-50 megacycle bands with power outputs of 30 and 50 watts for mobile stations and 50 and 250 watts for fixed stations. The 250-watt fixed station consists of a 50-watt station plus a 250-watt power amplifier, designed on the block-building plan.

Mobile and also fixed stations were developed for the 152-162 megacycle band for taxicabs and other users of such equipment. The mobile stations are single units incorporating plug-in transmitter and receiver-vibrator, dynamotor power supplies, and control circuits. The mobile transmitter has a power output of 17 to 25 watts, depending on frequency; the receiver audio output is one and one-half watts.

Both the 25-50 megacycle and the 152-162 megacycle fixed stations can be controlled either locally or remotely.

A new portable 60-watt station for the 30-44 megacycle band consists of a transmitter, receiver, and control panel in an aluminum trunk. It is operated on 117 volts a-c and is intended for use where station location is subject to change, as in flood-relief work and forest-fire fighting.

RECEIVERS

Radio . . . *Self-charging*

AMONG three new portable radio receivers was a 17-lb self-charging model with a 2-volt storage battery rechargeable by plugging into ordinary a-c house power. A 5-tube set with built-in Beam-a-scope antenna, it is equipped with a 5¼-in., alnico 5, dynapower speaker. Another portable receiver, in lightweight plastic (Fig. 42), operates on a-c or d-c power or batteries and weighs only 11 lb.

There were two new FM-AM table sets, a table-model radio-phonograph combination, three console combinations, and an eight-model line of low-priced AM table receivers.

Television . . . *"All-service"*

Production of television receivers was at a high rate. Among new models were two table receivers—one with the 10-in., the other the 12-in., aluminum-backed picture tube (FIG. 43) to improve picture brilliance and contrast. There was also a projection set for customized installation, with a screen 18×24 in. Two combination "all-service" receivers incorporate television, frequency modulation, amplitude modulation, short wave, and phonograph with long-playing as well as standard record-playing facilities.

Fig. 42. A lightweight portable radio that uses a-c or d-c power as well as batteries. With complete battery pack installed, it weighs only 11 lb

Phonograph Units . . . *Microgroove*

A phonograph attachment for playing microgroove records was produced for two phonograph combinations. The unit may also be used with other combinations equipped with preamplifiers.

Combination receivers were equipped with a second tone arm, the record changer operating automatically with standard records and manually with long-playing ones. A single tone arm used in two television-radio-phonograph combinations provides for detachable reproducing heads for operation on long-playing and standard records, as desired.

Components . . . . *Spacing-saving*

New television components for use with 10-in. picture tubes utilize permanent magnets in many places, eliminating much wiring and space consideration.

A phono-preamplifier designed for use with the variable-reluctance pickup operates on power from a wall socket and need not be wired into the receiver chassis.

A variable-reluctance cartridge accompanying the new long-playing records is reduced one-third in size.

SPECIALTIES AND INSTRUMENTS

A CHILDREN'S console-model record playe (FIG. 44), capable of playing records of all sizes u to 12 in., employs two tubes and has a 5¼-in., alnico permanent-magnet speaker. A metal grille guar against children poking objects through the speake The device is approved by Underwriter's Laborator

For use in buses there was developed an FM receiver for fixed-frequency operation, which can powe eight speakers. Crystal-tuned to the one FM statio desired, satisfactory reception has been obtained up t 20 miles from the transmitter.

The single-sideband selector (FIG. 45), which provides improved reception in crowded amateur and communications radio bands without affecting the qualit of the received signal, permits twice as many signals o stations in a band and up to 75-percent increase i transmission efficiency.

A new binary scaler will count electric impulses a speeds up to 200 kc, sufficient for nucleonics and computer applications. A self-contained plug-in unit, th scaler is designed for direct coupling, requiring n intermediate stages.

Among new test instruments is a distortion and nois analyzer combining four basic functions: measurin percentage distortion down to 0.1 percent; measurin hum or noise on an audio signal; acting as a high sensitivity vacuum-tube voltmeter; and performing as frequency meter over the range of 50-15,000 cycles.

Fig. 43. New table-model television receiver, with 10-in. picture tube, gives a brilliant and contrasting picture

An industrial oscilloscope was developed specificall for service applications in the field of industrial elec ronics, for servicing resistance welders, motor-control ircuits, power supplies, photoelectric circuits, etc. There were also three new regulated power supplies: a dual, a 450-volt, and a 1500-volt. For use in school and ollege research projects and in scientific laboratories here was produced a new square-wave generator.

An AM broadcast-station monitor which can detect he difference between 1,000,000 and 1,000,001 elecrical impulses per second measures the over-all perormance of standard broadcasting stations.

ELECTRON TUBES

Receiving . . . *Two-stage Amplifier*

A NEW receiving tube permits the design of a two-stage amplifier with a single tube—a twin-triode oltage amplifier, specially designed, processed, and ested for very low values of noise, hum, and microhonics. The nine-pin button base of the new tube liminates top caps. The amplification factor is 40, and he mutual conductance 1500 micromhos per section.

Fig. 44. Console cabinet for a child's record player provides convenient storage space for records and toys

Two new subminiature receiving tubes, including a adio-frequency pentode and a double triode, designed nd developed for the Air Force, are of such small size nd outstanding performance as to make them of great echnical interest.

The first of a line of receiving tubes (Fig. 46) designed or navigation equipment on commercial air lines was ntroduced. The severe vibration and intermittent peration to which tubes in such service are subjected ecessitated complete mechanical redesign.

athode-ray . . . *Better Pictures*

Two new models of direct-view, daylight television icture tubes were introduced, one having a 12-in.-iameter bulb to provide a picture approximately 7×10 in., the other a 10-in. bulb for a 9-in. picture. A metalized screen doubles the brilliance of the light and gives greatly increased picture contrast and detail over the nonmetalized types.

For radar equipment, which is subject to stringent operating conditions and must function 24 hours a day at sea or in the air, a cathode-ray tube was developed with a screen surface about 5 in. wide, on which the signal is visible in daylight as well as darkness.

Development progressed on a metal cathode-ray tube, sturdier and about one third as heavy as a glass tube of the same size.

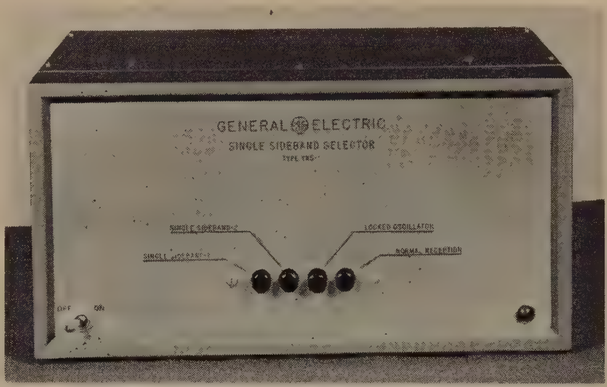


Fig. 45. Single-sideband selector greatly improves reception in the amateur and communications radio bands and permits twice as many signals in a band

Transmitting . . . *10:1 Power Gain*

A new forced-air-cooled pulse amplifier triode was introduced for the high-power (1 megawatt) Loran transmitter. A double-section grid allows a high amplification factor to be obtained with little or no increase in driving power over that required by a low-amplification-factor tube. A power gain of 10:1 is thereby attained even at peak currents in the order of 240 amp.

Fig. 46. Greatly strengthened electrodes and new methods of mounting them to withstand vibration feature this receiving tube for navigation equipment on commercial air lines

Industrial . . . *No Snubber Circuit*

A new thyratron (Fig. 47) rated 1500 volts and 3.2 amp was added to that line of quick-heating inert-gas-filled tubes for control. Lower in rating than tubes previously available for such uses and combining temperature characteristics of gas tubes with the long life of mercury tubes, the thyratron considerably broadens the field for such tubes.

Fig. 47. A new quick-heating inert-gas-filled thyratron for control applications does not in most cases require a snubber circuit

The world's largest modern street lighting unit—60,000 lumens, nearly one yard high and 21 in. in diameter—suspended in a light-measuring device for test. Beneath it is the smallest unit

LIGHTING

Street Lighting . . . *More Accurate*

HIGHER levels of illumination, more uniform pavement brightness, and reduced glare are the most recent trends in street lighting. Properly balanced, these factors make for good visibility and greater safety on our streets and highways.

More accurate control of the distribution of light is one of the many features of the new Form 109 luminaire (Fig. 48) which, in addition, will operate the 16,000-lumen F-H1 and the 21,000-lumen E-H1 mercury lamps in a horizontal position. The precision control inherent in the Form 109, its versatility, low-angle shielding, and high utility are features that make it one of the most important contributions to better street lighting in many years.

With another, the Form 110 luminaire, the problem of switching on and off lights of suburban streets, isolated traffic circles, underpasses, and rural intersections has been solved. The main feature of the Form 110 is a built-in photoelectric control. Designed for use on existing multiple circuits, the Form 110 will go on and off at predetermined levels of daylight and is adjustable between 1 and 6 footcandles.

Economical higher levels of illumination on business streets and expressways are possible with the new Form 108 luminaire, designed to operate lamps up to 25,000 lumens and particularly adapted for "big city" white-way lighting.

Floodlighting . . . *Well-lit Ball Park*

Briggs Stadium, home of the Detroit Tigers, became the best-lighted major-league baseball park during the year. A total of 1328 giant L-69 floodlights, each with a 1500-watt lamp, illuminate the entire field to a level of more than 200 footcandles.

Two new, general-purpose floodlights—500-watt and 1000-watt—now available are both made with hinged doors for easy servicing.

The use of floodlights, with water-cooled and air-cooled mercury lamps, as searchlights and in the photographic and printing industries is now possible with a small self-contained control unit.

Traffic Control . . . *Eliminates Whorls*

Better visibility and higher sustained efficiency are features of a new traffic signal. The optical system employs a caged glass reflector that eliminates the whorls and other deficiencies of blown glass. New mounting and gasketing provide a dustproof seal.

Indoor Lighting Control . . . *Photoelectric Control*

Insufficient illumination is perhaps the greatest cause of eyestrain. To be certain that lights are switched on when the light intensity falls below the adequate level, photoelectric light control has been controlling illumination in offices, factories, drafting rooms, schoolrooms, and public buildings.

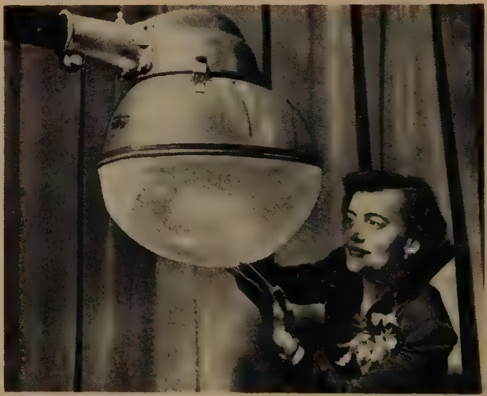


Fig. 48. The new Form 109 luminaire, designed for accurate control of light distribution from large mercury and incandescent lamps, with minimum glare

A newly designed photoelectric indoor system control gives a signal, in the form of an indicating lamp, when lights should be turned on. The indicator serves either with control, for automatic operation, or as a signal, for manual operation.

Fluorescent Lamps . . . *"Soft White"*

A fluorescent lamp designed to be complimentary to the human complexion, foodstuffs, and materials of interior design is the new "soft white" lamp, which supplements other white fluorescent lamps of still different characteristics.

In addition to investigation of the public's color reference, development of this lamp involved research new phosphors and hundreds of measurements on he colors of human complexions.

A major fluorescent lamp improvement during the ear was the development of an 85-watt lamp, which roduces the same high light output, maintains the ame long life, and has the same over-all dimensions s the older 100-watt lamp. The new lamp will afford saving of about 14 percent in electricity used to supply he same amount of light as does the 100-watt size.

otel Lighting . . . *Modern Effects*

Fluorescent lighting for Cincinnati's ultramodern 'errace Plaza Hotel (Fig. 49), considered to be one f the most progressive buildings constructed in the ast decade, includes the use of General Electric's new soft white" lamps in the bathrooms and as illumina-ion for the full-length mirror in each room.

Further effective use of fluorescence in the guest ooms is made by focusing lamps of the proper brilliance n beds and desk cabinets and near easy chairs for eading and writing.

Lighting tricks were tried with brilliant success on he outdoor dining terrace (in winter a skating rink). Beams from 30 projectors, located behind a parapet leven stories above, flow into a long mirror set at the dge of the parapet and down 150 ft onto the terrace. 'he "atmosphere" of the terrace is changed at will by ringing colored screens into the beams of light, hrough the use of automatically controlled frames.

otel Solarium . . . *Homemade Sunshine*

Atop the Hotel Senator in Atlantic City the com-ercial reality of what had once been an engineering xperiment in making synthetic sunshine was achieved.

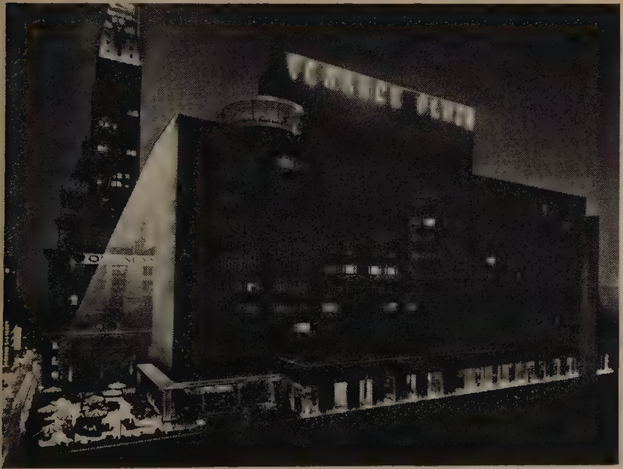


Fig. 49. Exterior view of Cincinnati's Terrace Plaza Hotel at night, showing the fluorescent-lighted summer dining terrace and the Gourmet Room atop the roof

he hotel's rooftop solarium, equipped with eight large -E Uviarc lamps, a number of household Sunlamps, id 192 incandescent lamps, closely duplicates the ree components of sunshine: light, radiant warmth, and that portion of ultraviolet radiation considered good for suntanning without need of goggles.

The success of the original installation has been so great as to require the building of a new one twice the original size.

Shasta and Grand Coulee Dams . . . *Guard-rail Lighting*

Long, slim fluorescent tubes have been fitted under the semicircular guard rails across the tops of Shasta and Grand Coulee Dams. Their light will shine down on the roadway, but will be shielded from the eyes of tourists who do their sightseeing after dark.

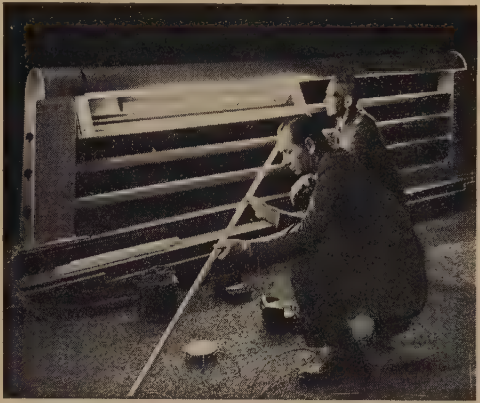


Fig. 50. Illuminating engineers measure the light output from a section of railing for the roadway at the top of Shasta Dam

To make sure that the system would work as planned, the Columbia Electric Company, Spokane (Wash.), maker of the railing, shipped a section of it to the Nela Park laboratories. There, engineers made exacting tests (Fig. 50) and recommendations to insure the maximum lighting efficiency of the system.

Germicidal Lamps . . . *Four Intensities*

A 36-in. Slimline type germicidal lamp, capable of operating at four different germ-killing intensities, was announced.

At its lowest current rating (120 milliamp), tests show that it produces six ultraviolet (germ-killing) watts, more than double the output of the standard 15-watt germicidal lamp and about the same as the 30-watt. Because of its smaller diameter, the new lamp will increase the radiating efficiency of existing 30-watt germicidal fixtures which may be modified to receive the new lamp.

Sealed Beam Headlamp . . . *For Locomotives*

Newest development in the field of locomotive headlamps was the adaptation of the all-glass Sealed Beam type automobile headlamp to railway service. A 200-watt 30-volt lamp in a PAR-56 bulb seven inches in diameter; it develops about 200,000 maximum beam candlepower with a beam spread of about twelve degrees horizontally and eight degrees vertically. Since the filament, the highly accurate reflector, and the clear cover glass are a single unit, the need for focusing and cleaning of the reflector is eliminated. Only the cover glass must be cleaned.

PAR-38 Floodlamp . . . *For Railway Cars*

By redesign of its filaments for railway-car power supply, the PAR-38 floodlamp was made available for railway-car lighting in 25- and 75-watt sizes. Among its many advantages for such use, the PAR-38 is less subject to breakage from water or snow striking the burning lamp than are those previously used.

Truck Signal Lights . . . *More Effective*

More effective STOP and TURN signal lights for the nation's nearly seven million trucks are expected to result from studies made at Nela Park by the Society of Automotive Engineers.

More than twenty lights of various sizes, colors, and intensities were viewed from distances up to 500 ft, under both night and day conditions. It was determined that lights should be red or amber to the rear and preferably red, amber, or white to the front, should be at least four inches in diameter, and need not bear printed instructions or arrows.

One of the chief problems was that of selecting signals with sufficient intensity to be effective in the sunlight, yet not so bright as to be blinding at night. G-E engineers devised as laboratory test equipment red and amber lights which were adjustable in size from two to eight inches in diameter and capable of intensities of 5 to 500 candlepower.

Airplane Taxiing Light . . . *Specifically Developed*

During the year a 28-volt 150-watt lamp was produced specifically as an airplane taxiing light. The lamp has an approximate maximum 30,000-candlepower intensity and a beam spread of approximately 50 degrees horizontal and 10 degrees vertical.

Light Meters . . . *Accurate Measurement*

A new technique for constructing light-sensitive cells, to make possible for the first time more precise measurement of illumination in the field, was responsible for the development of three new intensity-measuring instruments. The new construction corrects almost completely the errors, often as great as two to one, in previous light and exposure meters; it consists of the cementing of proper lenses and, in some cases, filters to the cells themselves.

New instruments included: a pocket-size light meter whose accuracy is within 10 percent for any color of light or angle of light incidence; the low-range precision light meter, with the mounting of the cell in gimbals similar to those used in naval gyro compasses and sensitivity 100 times that of the pocket meter; and the multirange precision light meter, having ten times the sensitivity of the pocket device.

Fluorescent Lamp Ballast . . . *No Leads: Less Noise*

A radical departure in design of ballasts for fluorescent lamps was made in 1948. New units for Slimline lamps employ terminal boards for wiring connections, thus eliminating the need for difficult-to-manage leads and for time-consuming cable splicing. The new ballast costs less, reduces installation time, and is inherently quieter in operation.

400-watt Mercury Lamp . . . *Improved Design*

The inner arc tube of the 400-watt (E-H1) mercury lamp was redesigned, and the outer envelope of special heat-resistant glass was made larger and in a different shape. The new design attains a higher initial efficiency (52 lumens per watt), larger volume of generated light (21,000 lumens), and a longer life.

Fluorescent Starter . . . *For D-c Operation*

A new starter announced for d-c operation of standard 30-watt and 40-watt fluorescent lamps fits the conventional lampholder and starter combinations as well as the separate two-contact starter sockets. It is the two-terminal glow-switch-type starter, for either d-c or a-c use.

AIR CONDITIONING

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WHILE extensive developmental work was conducted in such fields as the "heat pump," attention was confined primarily to new products throughout the air-conditioning and commercial-refrigeration line and to refinements in automatic heating equipment.

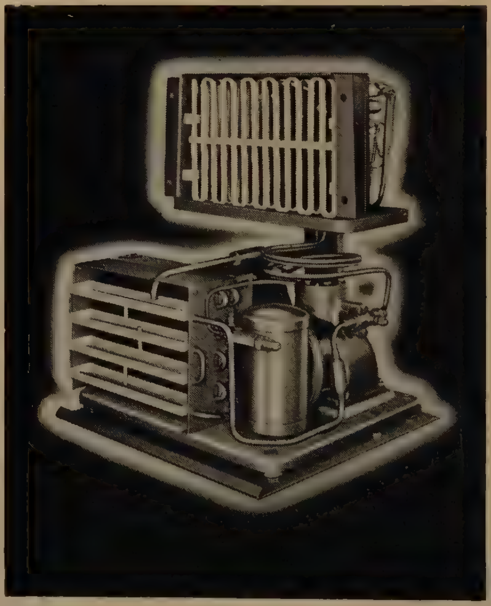


Fig. 51. Condensate in the candy merchandiser is evaporated during its progress through four drip pans

Automatic Heating . . . *Increasingly Compact*

Several automatic home-heating equipments underwent design changes to effect, among other advantages, reduction of unit size—important in today's trend toward smaller, utilitarian dwellings. Draft diverters on gas-fired warm-air furnaces were completely enosed within equipment jackets, thereby improving pearance and reducing necessary headroom.

Unit width of the gas-fired boiler was reduced sub- ıntially. Quieter and more flexible operation was hieved by improvements in unit burners and mixing bes. Use of an electric switch on low-water cut-offs hieved greater simplicity and reliability.

Among new equipments were two additional oil-fired ırm-air furnaces—one with an output of 115,000 u per hour, the other 155,000. Their compactness rmits space-saving installations.

ckaged Refrigeration . . . *Self-contained*

In the self-contained refrigerated candy merchan- ser, the emptying of pans of condensate at frequent ervals has been made unnecessary by a series of four ip pans bonded to the face of the condenser coil IG. 51). The drain line from the interior of the cabinet ıds into the first pan; as the water drips from pan to n, it is evaporated by the warm condenser air.

Three sizes, including a 2-, a 7½-, and a 10-ton model, re added to the line of packaged air conditioners, eviously available only in 3- and 5-ton models. These e self-contained and can be used with or without ct work.

frigeration Machines . . . *and Remote Equipment*

Hermetically sealed compressors were incorporated o a line of flat-base condensing units readily adapta- e for use in self-contained refrigeration products. esigned for use by fixture manufacturers, 32 types d sizes range from 1/6 to ½ hp.

New remote-type air-conditioning equipment of uilding block" construction affords easy assembly der a variety of installation and application condi- ons. In five frame sizes in both horizontal and vertical IG. 52) types, twenty-eight application arrange- ents are possible.

A new method was developed for bonding coil fins the tubing on some types of coils. A high-speed tating cam within the coil tube is arranged to pro- ce a series of rapid impacts which effect a tight and rmanent bond between the fin and the tube itself.

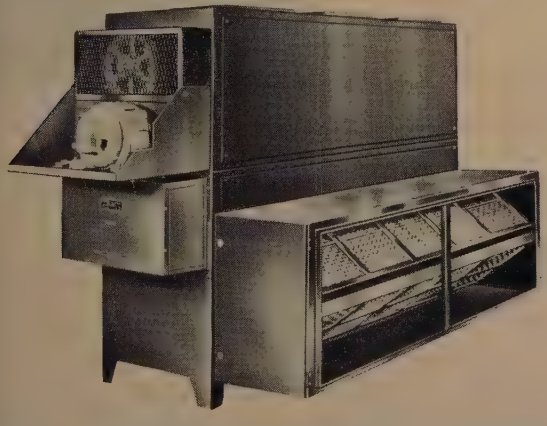
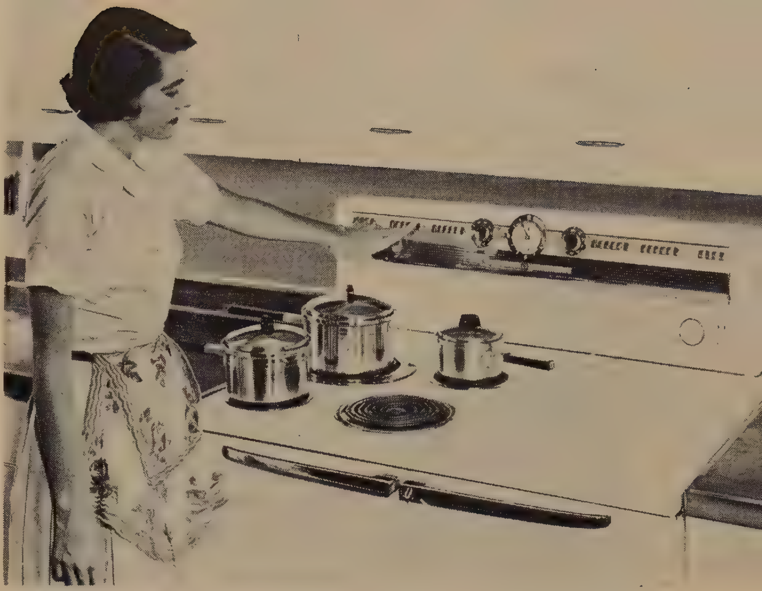


Fig. 52. A new central-plant air conditioner, of building-block construction. The vertical discharge arrangement is shown at the top



Cooking with color! The double-oven electric range with push-button controls allows the homemaker to tell at a glance, by colors, which unit is turned on and at what heat it is set

APPLIANCES

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Ranges . . . *Push-button Cooking*

OUTSTANDING in the "brand new" category were electric ranges. Two Hotpoint ranges and two of the new General Electric ranges were equipped with push-button controls. One of the latter was the first double-oven range introduced by the Company since the war; the other is a single-oven range with built-in pressure cooker. The new push-button controls not only simplify cooking operations but also provide more direct control of surface, oven, and broiler units. At a touch of the button, the heating element is switched directly to the speed chosen, without going through several other switch positions. Bright colors shining through the cool, transparent plastic buttons show immediately which unit is "on" and at what heat. The new switches are tested for 60,000 operating cycles, the estimated equivalent of 15 years of trouble-free service. They are push-open switches with solid silver contacts. A cam interlock prevents closing of two or more circuits on one switch at the same time.

The push-button ranges—as well as a new medium-price deluxe range with improved rotary switches—are characterized by a new high-back control panel which is easier to clean, easier to see, and easier to reach. Because heating-unit controls, automatic oven timer, and minute timer are mounted on this panel, ten inches above the surface of the range, there is no need to grope behind hot cooking utensils to operate the range. The control panel is hinged and can be tilted forward for servicing from the front of the range.

Refrigerators . . . *Farmers and Freezers*

Two new ten-cubic-foot refrigerators—one, a low-priced standard model designed particularly for farm use, the other a combination refrigerator and home freezer—were introduced. The latter has two separately refrigerated, completely insulated compartments, each with its own door and its own control. The upper compartment, two cubic feet in content, maintains a temperature of 0 F for the freezing and storage of food for as long as a year. The lower compartment is 8 cu ft in content and maintains about 38 F for normal fresh-food storage. Defrosting of this section is completely eliminated, and there is little drying out of food.

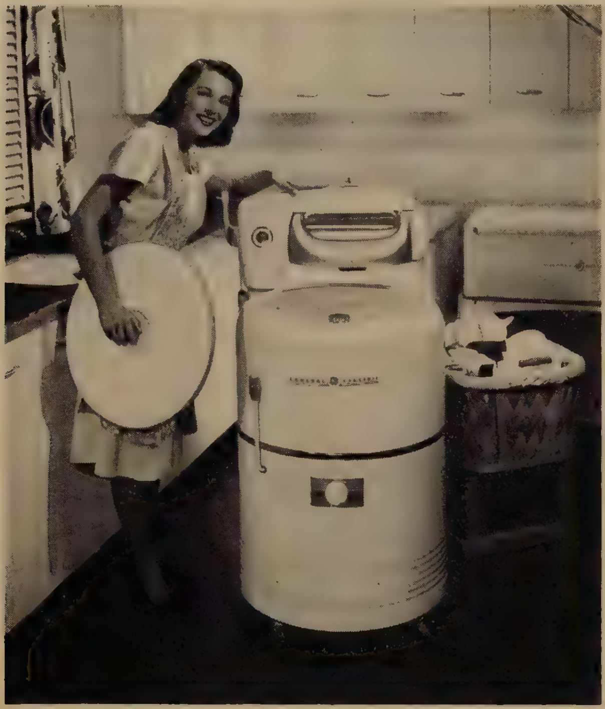


Fig. 53. A new wringer, which gives the operator split-second control of the rolls, was introduced with this deluxe washer

Water Heater . . . *For Small Homes*

Developed primarily for use in the kitchens of small houses without basements was a 40-gal base cabinet-type electric water heater with four square feet of porcelain-enameled work surface. The new heater occupies no more space than does a comparable 30-gallon model. As in all other 1948 G-E heaters, water is heated by Calrod heat-wrap units which encircle the galvanized steel tank. A new and larger magnesium rod in the tank protects the steel against excessive corrosion in aggressive water areas.

Wall Heater . . . *Radiant—Convection*

A built-in electric wall heater, produced for use in bathrooms and other rooms where additional quick heat is desired, operates on the radiant-convection principle. The unit is rated 1320 watts, 115 volts a-c or d-c and delivers heat at the rate of 4507 Btu per hour.

Washers . . . *Quick Control*

Introduced in the home-laundry field was a deluxe washer (Fig. 53) with a new wringer which gives the operator split-second control of the rolls. When the wringer is operating, a slight push or pull on it—o gentle tug on clothes going through—instantly sto the rolls; pressure can be released by striking the pr sure bar above the rolls. The washer, largest in t Company's line, holds ten pounds of dry clothes.

Also announced were a new low-priced wring washer and a washer with a built-in timer to cont the agitation action for any period up to 15 minut

The all-automatic washer was improved by conso dation of the temperature, time, and cycle controls in a single set of controls on the righthand side of wash Changes in the washer's water connections permit to be placed within approximately one inch of the ba wall. To meet municipal plumbing-code requiremen an antisiphonage system was also incorporated.

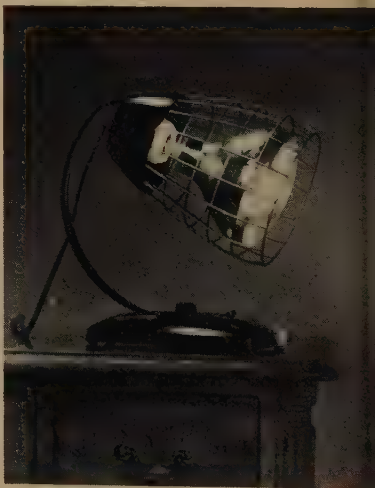
Vacuum Cleaner . . . *Throw-away B*

A convenient and sanitary throw-away bag whi simplifies disposal of dirt, was incorporated into a ne tank-type vacuum cleaner. Made of highly poro pressed cotton, the bag is inserted inside the regul cloth filter bag. When filled with dirt, it can be r placed in a matter of seconds and thrown away, di and all.

Heat Lamps . . . *Porta*

In addition to a new line of heating pads, the Co pany announced a new, portable, infrared heat la (Fig. 54) for treatment of muscular aches and pai The unit consists of a bulb with a self-contained r flector, a wire grill to protect the bulb, and a ligh weight base. Mounted on a wall by means of a keyho slot or fastened to a bed or chair with a spring cli the lamp can be tilted to beam its rays in almost a desired direction.

Fig. 54. The design of the portable infrared heat lamp allows it to be so tilted as to beam its rays in almost any desired direction



Automatic Blanket . . . *Signal Wi*

Another new product was the deluxe automat blanket. Instead of thermostats, this extra-large 7 percent-wool bed covering has a "signal" wire, inco porated in the same insulating jacket as the heati wire but separated from it by a special insulating m terial. When necessary, this combination transmits nal to the control to guard against overheating of e blanket.

cks . . . *Grandma 'n' Grandpa*

Among the new electric clocks announced by the mpany were a model with a melodious bell alarm, andfather and grandmother hall chime clocks, and a antel chime clock. Several new designs were an- unced by Telechron Inc.: the Decorator kitchen ock; a new advertising clock; an 8-in. commercial wall ock; and a redesigned model of Telechron's 12-in. mmercial wall clock.

ONSTRUCTION IATERIALS

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mote-control Wiring . . . *New Features*

AMONG the year's developments in the construction-materials field was a new remote-control ring system (FIG. 55) which makes possible a more xible method of controlling lights and outlets in in- strial, commercial, and residential wiring. Thus, even v-cost homes can now include many new features at enhance modern living.

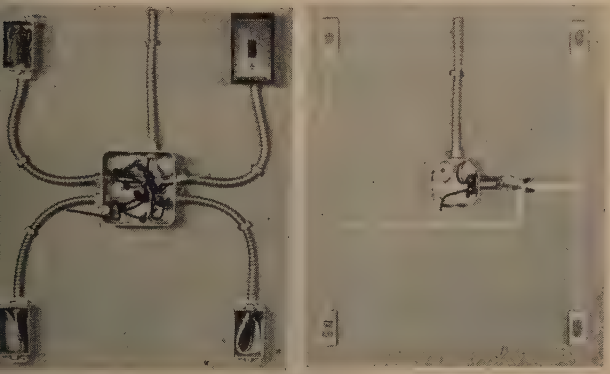


Fig. 55. Remote-control wiring system (*right*) eliminates the need for much of the large, special equipment required in conventional wiring systems (*left*). Switches are connected to the outlets, not by cable, but by a new lightweight Flamenol insulated wire operating at only 25 volts

Including a new line of wiring materials, this system minates some of the large, expensive equipment while ending the uses and convenience of electricity. It is w possible to have any number of controls for certain nts or outlets where formerly the cost of installing re than one switch would have been prohibitive. mote-control wiring is not subject to the same code trictions as conventional wiring, since it operates at y 25 volts.

rcury Switch . . . *Makes and Breaks*

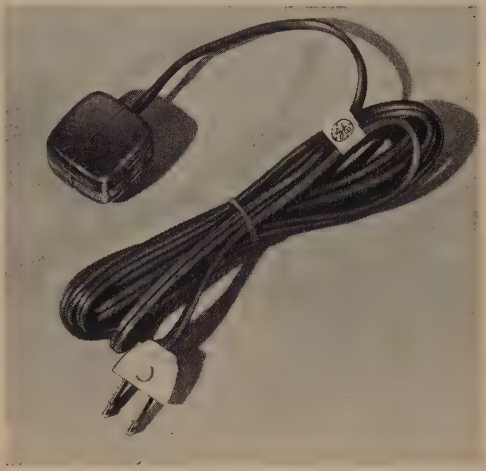
A new, silent, mercury switch, with a 10-amp rating 125 volts, replaces the former 5-amp switch. Doubling interrupting capacity in the new switch permits a much wider use in home and industry. Capable of controlling an electric installation up to 1200 watts, including Type C loads, it has been tested for a half-million "makes and breaks."

Other Developments . *Cables, Fuses, Taps, and Switch Boxes*

There were other announcements in the construction materials field: a new tap and extension-cord set with triple outlet (FIG. 56); a new line of improved sectional switch boxes; a renewable fuse with a time delay that keeps it on the job regardless of harmless momentary overloads, and at the same time gives quick protection against harmful overloads and shorts.

A new, nonmetallic, sheathed cable withstands weather extremes, fumes, corrosive vapor, and most fungi; it is resistant to flame, moisture, oils, acids, alkalis, impact, and abrasion.

Fig. 56. The new cord set has an ivory-colored plastic plug, permanently molded to the Flamenol cord, and carries a triple outlet

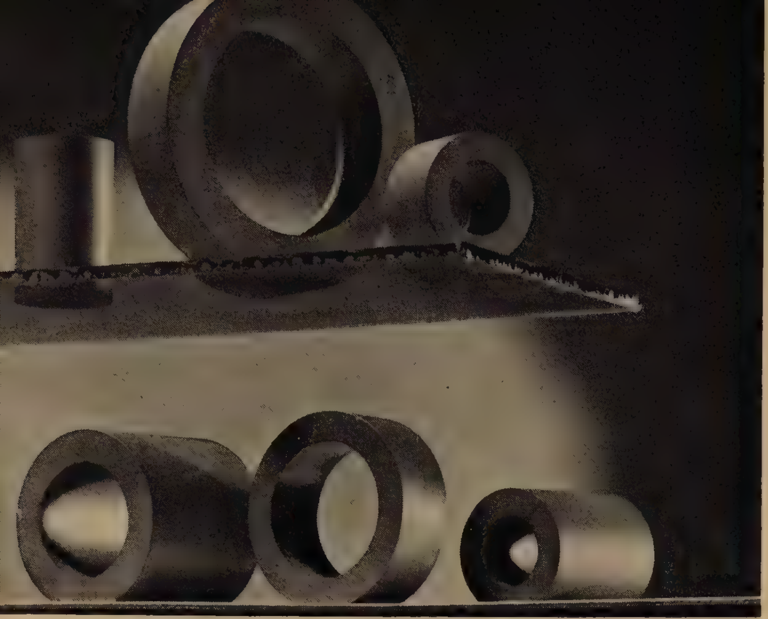


A combination line developed by Monowatt, Incorporated combines two or three devices on a single-gang wall plate. Single-pole switch, three-way switch, outlet, and pilot light may be used in numerous combinations. A new triple-outlet and wall-plate combination screws flush to the wall without adjustments. A new trouble light features a convenience outlet as an integral part of the handle. Silicone-treated asbestos-type leads for temperatures up to 200 C (392 F) and No. 14 nickel conductors are features of a new connector for use with PAR-38 floodlamps.

Still other Monowatt developments of the year were a service block having the two Textolite plastic halves held together by a blind drive pin; a Circline lamp connector with body molded to conductors for strain relief; and an attachment cap that snaps together to hold cord and blades firmly for positive electric contact—permitting wiring without tools.

Residence Panel . . . *Attractively Styled*

A residence panel for fuse protection of residential lighting systems, announced by Trumbull, was styled for location in kitchens and hallways. The interior is completely removable for ease in wiring; concealed wiring gutters safeguard the user from contact with current-carrying parts.



Standard all-purpose carbide bushings serve a multitude of uses as wear-resistant parts. The bushings shown are one of the increasing number of applications of Carboloy cemented carbide to prolong the life and increase the efficiency of machinery and equipment

CHEMICAL AND METALLURGICAL

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NEW RESINS AND PLASTICS

Hycar Phenolic . . . *High Shock Resistance*

THE high shock resistance required by instrument cases, knife handles, power-tool handles, and a variety of other applications which undergo rough treatment were achieved in a new Hycar phenolic molding powder. The compound has the good moldability and heat resistance of wood-flour-filled phenolics, and is strengthened by the toughness and resiliency of Hycar-American rubber, a product of B. F. Goodrich Chemical Company for many applications. It can replace cotton-flock and rag-filled compounds. The resistance to impact is many times more than that of standard wood-flour-filled phenolic materials.

Resin Emulsions . . . *For Leather Finishing*

Two new emulsions, designed for the leather-finishing industry, contain a tough, flexible resin which on evaporation yields a clear, colorless film that is nonhardening and exceptionally low in water absorption. One, incorporating a tacky resin, was developed especially for use as a clear sealer coat for leather splits or as a binder in pigmented covering coats. The other, nontacky, is used as a clear finish for fine side leathers where pigment binding is not important.

Binders . . . *And Insulating*

A new phenolic resin, for use as a binder in sand cores used in the casting of metals, imparts enough dry strength to the core materials to allow the core to be handled while still warm.

For cementing metals and thermosetting plastic wood, fabric, or any combination of these material there was developed a modified phenolic liquid adhesive. This is especially useful for preparing metal-face sandwich-type construction, for attaching brackets an lugs to thin metal sheets, and in trailer, airplane fuselage, and prefabricated-house walls.

A thermosetting, phenolic drying-oil varnish tha cures to a tough, pliable mass even in the deepest coi can be used with practically all types of wire includin enamel, cotton, asbestos, and glass-covered.

PLASTICS APPLICATIONS

Housings . . . *The Large*

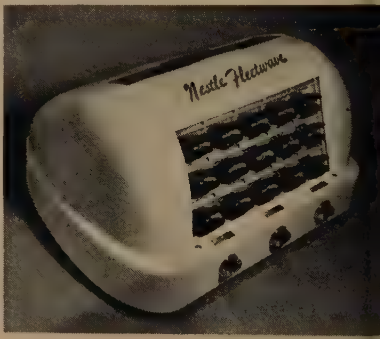
THE largest plastics product ever molded fro synthetic powders at Pittsfield was produced in th form of a housing for a permanent-wave machin (FIG. 57) made by The Nestle-LeMur Company c Meriden (Conn.). The housing, of urea formaldehyd is 21 in. long, 18 in. deep, 10 in. high, and weighs 10 lb

A fountain syrup dispenser of Canada Dry incorporates ten plastics parts, with polystyrene plastics use for all parts which come in contact with the syrup. Th dispenser provides either a premeasured or continuou flow of syrup through a single push-button control.

Sailboat . . . *12 ft, 300 l*

A 12-ft sailboat with a one-piece plastics hull (FIG. 58 has only half the weight of an average wooden boat c that size and is reputedly 10 times as sturdy. It wa molded for the Beetle Boat Company of New Bedfor (Mass.), of glass mat material and a plastics resin cured by steam and pressure. The boat accommodate six persons, is nonsinkable and leakproof, and require practically no maintenance for the hull.

Fig. 57. Pittsfield's largest molded case. More than a half ton of metal was removed from the original steel block to form the mold cavity



Laminated Products . . . *Better Phone Boot*

A telephone booth (FIG. 59) designed and produce by the Sherron Metallic Corporation has walls and ceiling, both interior and exterior, fabricated from Textolite melamine-surfaced panels laminated with phenoli varnish. The inner panels are perforated and backed b sound-absorbing acoustic material. Resistance to abrasion and ease of maintenance, as well as improved appearance, are among the advantages of such construction.

New patterns were added in the decorative laminated extolite materials used for table and desk tops, unters, kitchen work surfaces, and wall paneling.

ano Parts . . . *Superior to Wood*

A new use for plastics was for piano-action parts anufactured by Pratt, Read and Company. The parts iow better dimensional stability, particularly under ghly humid conditions; quicker and more complete turn to normal after exposure to extreme tempera- res and humidity; better adhesion of felts and ather; and less warpage and distortion under extreme nditions.

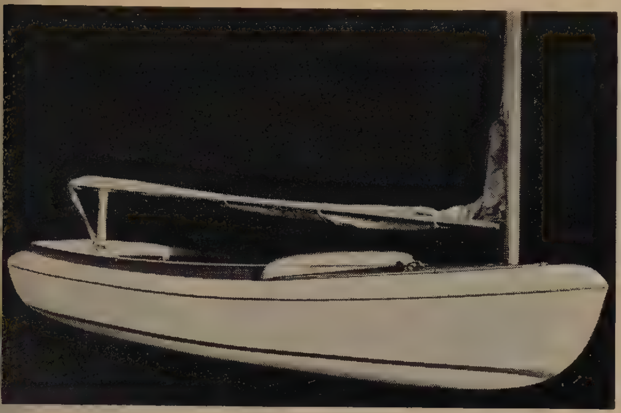


Fig. 58. One-piece plastic sailboat hull can be stored without regard to climate, is resistant to corrosion and decay, and is impervious to salt water and worms. The mast is of flexible aluminum

SILICONES

lass Cloth . . . *And Water-repellent*

A GLASS cloth coated with silicone rubber which will withstand an operating temperature of 520 was particularly designed for use as a gasket in dial and other aircraft engines. In both sheet and bricated forms the new cloth offers possibilities as an oning surface in laundries, curtains in bread-baking ens, and, in tape form, as high-temperature cable in- lation.

A new grade of Dri-Film, a water-repellent product rived from silicone materials, reduces water absorp- on in concrete and cement products, and is also used r treating ceramics, paper, plastics, and other ma- rials. Applied by spraying or brushing, the new pellent forms an invisible coating on walls, floors, and milar surfaces.

ew Applications . . . *Lively Golf Ball*

Silicone "bouncing putty," which can be pulled like ffy, bounced like a ball, or broken with a quick snap, came a material for the center of U.S. Royal golf lls, manufactured by the United States Rubber Com- ny. The silicone center is said to bring greater dis- nce and improved "click" and "feel" to the ball.

Silicone oil was put to work as a mold-release agent : injection molding of aluminum and zinc die-castings, helping to provide a smooth surface on the finished parts as well as facilitating production. The oil withstands 600 F, wets the mold readily, penetrating small cavities, and may be applied by brushing, spraying, or wiping.

Fig. 59. Textolite panels used inside and outside telephone booths assure resistance to abrasion and ease of maintenance

The use of silicone rubber (FIG. 60) was extended, not only as a gasketing material but also where its heat, chemical, and moisture resistance offered advantages. The material was applied as a valve seat in relief valves for domestic hot-water tanks because it will not adhere to metals or other materials at high temperatures. As a press pad in heat-sealing equipment it stands continued exposure to 300–350 F with no noticeable

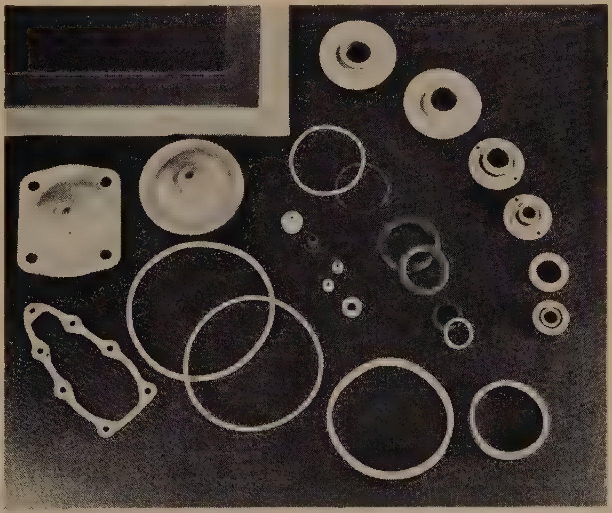


Fig. 60. Some representative molded and extruded samples of silicone rubber

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change in flexibility or surface hardness; it will not adhere to plastics, glass, cloth, metal, or other materials used in packaging.

METALLURGICAL PRODUCTS

Magnets . . . *Intricate Shapes*

A NEW method of sintering alnico 5, a permanent magnet material, permits the design of intricate shapes with higher energy than previously possible. The sintering process permits economical production of small parts, finer grained and less brittle, with smooth surfaces and close dimensional tolerances. The sintered material is being used in relays, meters, fountain pens, electronic reproducers, and compasses.

An interesting application for an alnico permanent magnet was a new wall-type can opener manufactured by the Rival Manufacturing Company. The magnet is attached to an adjustable arm on the side of the can opener. After the opener has cut off the lid, the magnet snaps it up and holds it tight until the can is removed.

A leakproof magnetic coupling for an improved liquid-level gage made by the Boston Auto Gage Company uses two sintered alnico 2 permanent magnets. The magnets work on opposite sides of an aluminum diaphragm which effects the seal.

Cemented Carbide . . . *More End Products*

Major trend in the application of Carboloy (cemented tungsten carbide) is its increasing use as an end-product material, according to reports from Carboloy Company, Inc. In such applications it usually serves as a component part of machinery and of other products, to resist excessive wear, prolong life, and increase operating efficiency. Among such applications of Carboloy were bushings in automatic screw machines, line guides for wire and textiles, guides and bearings for fish rods and reels, lathe work rests, powdered-coal nozzles, paint scrapers, cams and cam followers in machinery, core pins for ceramic and powdered-metal industries, dial gage indicators, brick mold liners, grinding-wheel molds, and paint-spray nozzle tips.

Carboloy dies for sheet metal, especially for blanking and piercing operations, were used increasingly. One manufacturer, with 4,000,000 hits already, expects 5,000,000 hits with his die before it will need to be serviced.

Carset rock-drilling bits, developed jointly by Carboloy and Ingersoll-Rand, were extended in sizes in both hammer-type and piston-type drills. Announced first in 1947, they were applied widely during the past year in mining, quarrying, tunneling, and highway and dam construction.

Drills of solid Carboloy cemented carbide, and also of a wear-strip type—more commonly known as gun drills—were successfully applied for drilling all types of holes in metals. In the woodworking field its ability to retain a keen cutting edge for long periods of time was increasing production, reducing production costs, producing uniform products with better finishes, and on some products eliminating sanding. Carboloy tips and inserts were applied on saws, cutter knives, contour planers, router bits, and other woodworking tools.

A Carboloy grade suitable for heading dies was attained, and a special casing method developed. In one application regular runs in making a quarter-inch screw blank average 5,000,000 pieces before the dies need servicing.

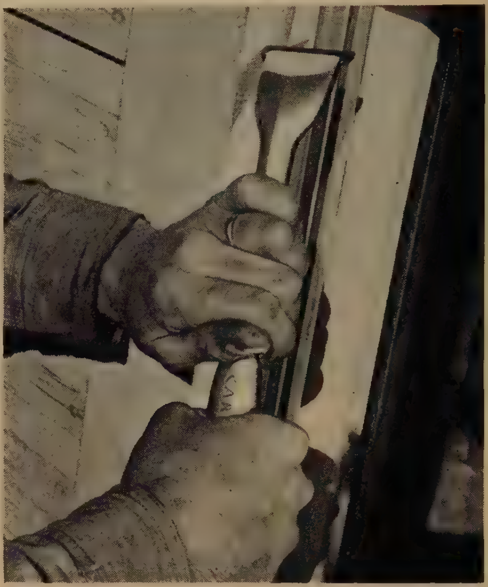


Fig. 61. The all-purpose paint scraper, with Carboloy cemented carbide blade, has four working edges and corners shaped to fit different moldings

In the cutting-tool field a survey by a trade publication showed that 44.2 percent of all new machines of the year were carbide tooled, and that 10 percent of the companies who reported were tooling entirely with carbides.

An automatic boring machine for valve guides was specially designed by a Michigan machine-tool builder to incorporate a solid Carboloy boring bar.

A fluted-shank masonry drill was announced for drilling both deep and shallow holes in concrete, slate, marble, plaster, and other hard materials. Adapted for portable drills and drill presses, the masonry drill is four times as fast as ordinary drills, and stays sharp up to 50 times as long.

A new line of Carboloy "insert" tools employs mechanically held bits that can be round, square, rectangular, or triangular, in grades for roughing, semifinish, and finish operations.

For the consumer there was developed the all-purpose paint scraper (Fig. 61) with a solid Carboloy cemented-carbide blade. It has four working edges and individually shaped corners to fit different moldings. All kinds of paints, lacquers, and hard enamels are removed, faster; and the blade stays sharp at least one hundred times as long as the conventional blade. Houses, boat hulls, furniture, signs, automobile bodies, and general woodwork are among the applications.

HIGH LIGHTS AND SIDE LIGHTS

High-speed, High-intensity Photolight

new photolight, displayed publicly for first time at the National Instrument ference and Exhibit in Philadelphia, vides an extremely high-intensity flash blue-white light of two microseconds ation, enabling photographers to snap cts moving in excess of 2700 feet per nd.

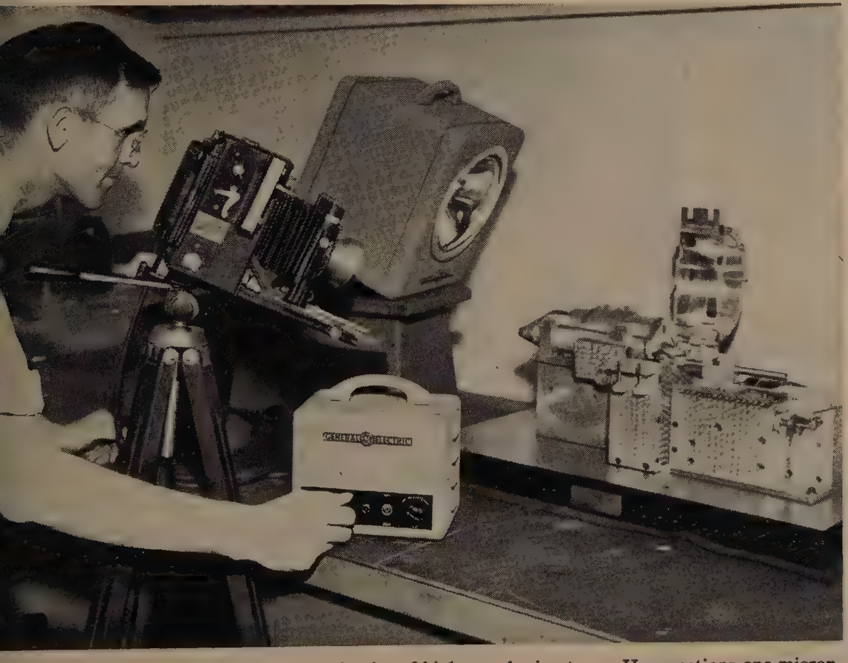
can be applied in research and elopment laboratories to study fluid , vibration, ballistics, and high-speed tional and linear motion of various ies.

he unit weighs only 25 lb, and consists new three-electrode, short-gap, high-sure, inert gas-filled tube with self-tained fixed-focus parabolic reflector a capacitor discharge-type power ply. It operates from a 115-volt single-se 50/60-cycle lighting circuit, and duces sufficient light energy to obtain atives of good quality when exposed lens aperture of f:6.3 or larger.

his fundamental unit, without acces-es, can best be used to photograph tinuously moving objects such as a am of water or a rotating wheel, where e synchronization of object and flash ot required.

or photographing phenomena which ir just once, such as an explosion or a et smashing a plate glass, an amplifier equired in addition to the lamp and power supply to assure precise synchronization of object and flash.

When the photolight and amplifier are used, the units may be precisely synchronized with objects to be photographed by any of the following methods: (1) closing normally open contacts; (2) breaking normally closed contacts; (3) by a pulse received from a crystal microphone; (4) by making or breaking a light beam when a phototube preamplifier and light source are used.



photolight is used in studying the mechanics of high-speed microtomy. Here sections one micron 000,000 meter) thick are being cut from the spleen of a mouse for cancer research. The knife e, rotating at 60,000 rpm, moves approximately 1100 ft per sec

Thinner-than-hair Paper for Capacitors

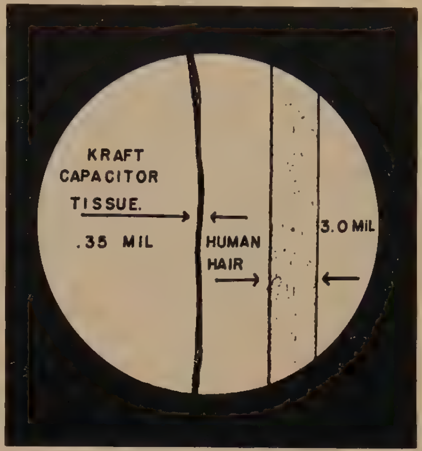
What is believed to be the world's thinnest paper is used in electric capacitors.

Made from the same raw material as an ordinary paper bag, this paper can now be made one-fifteenth the thickness of a sheet of newspaper or a fraction of the thickness of a single human hair.

Five thousand sheets of such paper would make a stack about an inch high, the thinnest sheets being but 0.0002 inch in thickness.

Capacitor paper is made of kraft, or wood pulp, beaten in water until each wood fiber is broken into microscopic fibrils. Approximately 900 pounds of water are used to produce every two pounds of capacitor paper.

The tiny fibrils are allowed to settle on a finely meshed wire screen, and long sheets of paper are formed by sucking the water out, leaving a semidry mat. The paper is finally dried by being carried on felt drying pads to large heated rollers.



The edge of a 0.00035-inch-thick piece of kraft capacitor paper is microscopically compared to a human hair. Believed to be the thinnest paper in use, capacitor tissue can be made as thin as 0.0002 inch thick

Each step in production of the paper is closely controlled to assure proper thicknesses and to prevent breakages.

The finished thinner-than-hair paper is used as insulation between aluminum foil windings in a capacitor, the largest capacitor containing more than one mile's length. Study of the molecular structure of the paper for desired electrical characteristics has made possible capacitors much smaller than formerly, for special electronic uses.

Mobile Measurements Exhibit

The Carnival of Measurements, General Electric's travelling exhibit of electric measuring devices has embarked on a tour of 80 major U. S. industrial cities.

The exhibit, which has already travelled 9000 miles in an earlier tour, will cover about 14,000 miles on its present yearlong trip.

Feature of the display is the new I-50 watthour meter, in which the principle of magnetic suspension is applied. The meter's rotating disk and shaft are suspended in space by the interaction of two tiny magnets.

The collection of instruments will be shown to schools, colleges, and representatives of utilities, industry, government, research laboratories, and municipalities.

(Concluded on next page)

HIGH LIGHTS (Continued)

The display consists of panels on which are exhibited aircraft instruments, photometric devices, remote position indicators, portable testing instruments, telemeters, and many other measuring devices.

After approximately two months on the Pacific coast, the exhibit will travel in the Southwest and Southeast, then up the Atlantic coast, completing its tour in the New York area next July.

Adjustable-speed Motor on Can-closing Unit

The installation of a Tri-Clad adjustable speed motor to operate a new high-speed filling and closing unit has enabled a large New York brewery to increase its output of canned beer without sacrificing any of the previous quality controls or production safety factors.

According to designers of the new closing unit, the motor is the first of its kind ever installed on this type of equipment in a brewery.

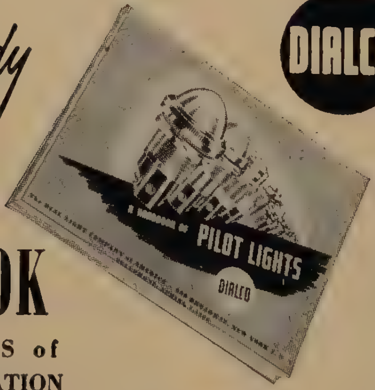
The three-to-one stepless adjustable operating speed offered by the motor enables the brewer to vary his output of cans from 105 to 315 per minute. Previous drives for this type of equipment usually consisted of motors with only fixed operating speeds or motors of two speeds with belt speed-changing devices, which often developed maintenance problems.

An air cylinder used in conjunction with a hydraulic clutch provides a braking system on the new unit which enables it to stop within 1½ to 2 cans, taking less than one half second when the unit is being operated at maximum speed. This feature represents a considerable saving in damaged cans and wasted beer in the event of a jam.

Variable operating speed of 3:1 on this canning - machine motor increases output without loss of safety or quality

Since the installation of the adjustable-speed motor, the work of the operator of the unit has been greatly reduced. . making speed changes, it was forme necessary for him to change motor spe by manually adjusting the belt spe changing device. He now controls entire unit by a finger-tip dial which p mits instant change to any desired spe

According to the past experience of plant engineers, the most efficient meth of cleaning these units is to wash th while they are running at the low speed. Here again the finger-tip di which gives full-range control, represe a saving in time and increased efficien



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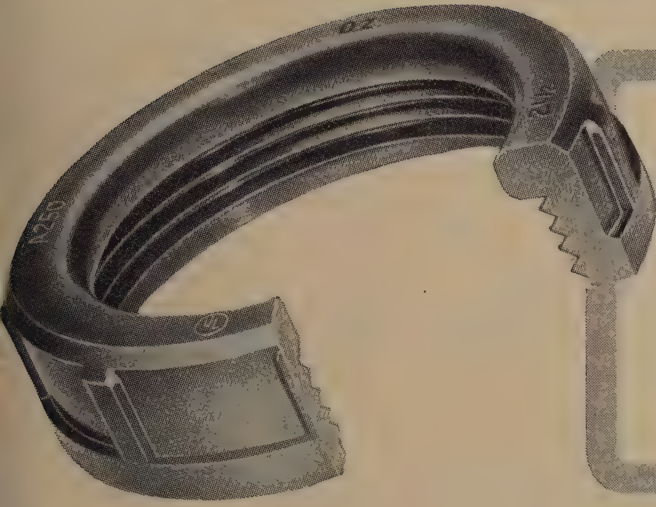

Results of Independent Laboratory Tests*

TORQUE .... O. Z. *PROVED 36% STRONGER* than other bakelite bushings tested.

IMPACT .... O. Z. *PROVED 44% STRONGER* than other bakelite bushings tested.

TENSILE STRENGTH .... O. Z. *PROVED 112% STRONGER* than other bakelite bushings tested.

FLAT COMPRESSION .... O. Z. *PROVED 32% STRONGER* than other bakelite bushings tested.

Now O. Z. offers you the strongest all-Bakelite insulating bushings made — 56% stronger overall than other Bakelite bushings tested in independent laboratory tests (results above) — they bounce like a ball if dropped, won't break even on concrete. And for fast, easy installation and permanent protection, O. Z.'s provide these *plus* features:

- **Smooth, rounded edges completely protect wire insulation during pulling and when in service.**
- **Clean, deep threads let you spin-on the bushing with a twist of the wrist.**
- **Ribbed outer surface provides a grip for slippery hands and permits tapping with screw driver.**

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0	½"	400	100	1½	$ 4.60	$ 3.60	$ 2.90
5	¾"	400	100	2	5.75	4.50	3.60
00	1"	200	50	3	9.20	7.20	5.75
5	1¼"	100	25	4½	26.50	20.30	16.25
0	1½"	100	25	6½	30.00	23.40	18.75
0	2"	40	20	9	36.00	28.10	22.50
0	2½"	20	20	14	58.50	—	36.50
0	3"	10	10	18	64.00	—	40.00
0	3½"	10	10	22	80.00	—	50.00
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0	5"	5	5	34	210.00	—	130.00
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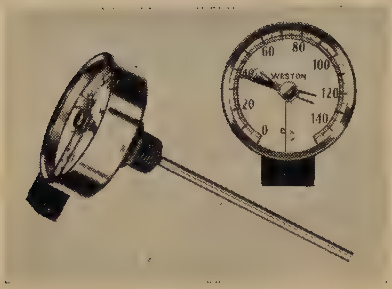
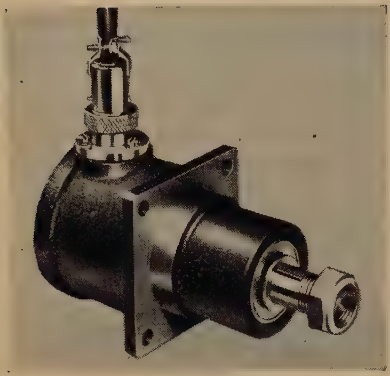
NEW PRODUCTS: AND WHAT THEIR MAKERS HAVE TO SAY ABOUT THEM



Thermometer



Tachometer

Thread Staging Fixture

The See-All thread staging fixture aids in inspection by optical projection of screw threads ranging in diameter from 0.073 in. to 1 in. It was designed for use on an AO optical projection comparator, Kodak contour projectors, Jones and Lamson optical comparators, and Model P.25 Portman comparators. Adapters can be supplied which make it suitable for use on Bausch and Lomb contour projectors and certain other vertical-type comparators as well. The methods of loading and holding screw threads provided by this fixture are both practicable and fast. The fixture furnishes a simple helix angle adjustment for use on those optical comparators in which no work stage with helix adjustment is provided. Two sets of adjustable vee assemblies readily interchangeable are supplied with each fixture.—*Engineers Specialties Division, The Universal Engraving & Colorplate Co., Inc., 980 Ellicott St., Buffalo 8, N. Y.*

High-voltage Generator

The new Model L Van de Graaff generator for a convenient source of high voltage, producing an appreciable constant-potential current for research and industrial applications. Utilizing the well-known moving-belt and corona-spray principle of the two-million-volt electrostatic units used in nuclear research and precision radiography, this instrument develops a quarter-million volts positive or negative. Current output is ample for a multitude of measurements, tests, and production uses yet is low enough to assure safety to operating personnel. Voltage output is easily adjusted by corona loading. Grounding the high-voltage terminal reduces voltage output to zero, allowing external circuit changes to be made without shutting down the generator. —*High Voltage Engineering Corp., 7 University Road, Cambridge, Mass.*

Thermometer

A new contact-making thermometer combines the features of an indicating thermometer with an alarm or control device. The instrument consists of an all-metal thermometer with an adjustable contact arm mounted in the glass and bezel.

A screw-type terminal block mounted on the periphery of the case front provides for an easy electrical connection. Contacts are of the magnetic type which assure positive action during making and breaking of the contacts. The contact arm is easily set to make contact at any temperature over the entire scale and, although contact can be broken manually after an alarm has been sounded, the contacts "break" automatically on a temperature change of about five percent.—*Weston Electrical Instrument Co., 617 Frelinghuysen Ave., Newark 5, N. Y.*

Tachometer

A new small-size low-cost electric tachometer, Model M-1200, designed for continuous operation. The new tachometer, housed in a cast-bronze case, will operate in any position through a wide range of temperatures. The unit is equipped with a large driving shaft, and grease-packed ball bearings assure accuracy and long life. Various shaft arrangements are available to meet a wide variety of operating conditions. A suitable assortment of indicating meters is available. —*The Electric Tachometer Corp., 2218 Vine St., Philadelphia 3, Pa.*

Compressor Motor

A new small-diameter motor designed to drive hermetically sealed refrigeration compressors. With a diameter of 4.790 to 4.792 in., it is available in ratings up to 1/8 hp, 1725 rpm, 115 volts, 60 cycles. The motor can be furnished with a rotor having a counterbored quill or with punchings made to fit directly over the shaft.

The new compactly designed motor was developed to aid compressor manufacturers in adjusting the size of their units to fit refrigerator space limitations.—*General Electric Co., Fractional-horsepower Motor Divisions, Schenectady 5, N. Y.*

Impact Tool

Model 8U electric impact tool for the laying of electrical cable, the installation of connectors, and public utility service work has a capacity for handling the heavier, harder jobs. With standard accessories, it will run and remove nuts up to 5/8-in. thread size; drive and remove studs; tap and ream; extract broken cap screws and studs; apply and remove machine screws of all kinds; drill brick, metal, and masonry; and run wire brushes. It can be used also for woodboring.

A reversible motor makes it as easy to remove screws, studs, and nuts as to apply them; motor burn-out is eliminated, even if the spindle stalls completely; the impact principle operates whenever resistance is met, providing extra power to push through the job.—*Ingersoll - Rand Company, 11 Broadway, New York, N. Y.*

D-c Recorder

A new portable d-c recorder for measurement of microcurrents and volt wherein the exact range required car individually selected. The minimum scale range of the instrument is 0 to milliampere and the maximum is 0 t amp. Sensitivity is one part in 1000.

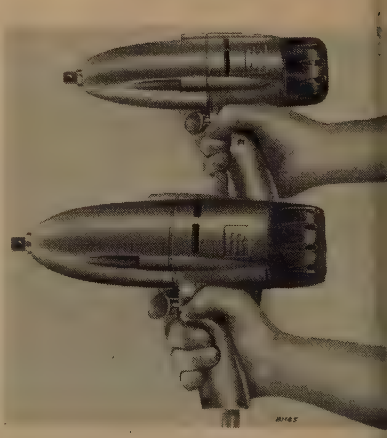
This recorder of the moving-magnet in changeable-coil type is designed for tinuous duty. Bearing friction and fric between the pen and chart are virtu eliminated. Eight different coils are av able and each is adjustable over a rang 11.5 to 1. The zero on the scale can suppressed up to 80 percent. The char circular 24-hr type, is driven by a ventional synchronous motor consum about 5 watts. The entire instrumen mounted in a hand-rubbed walnut cas *Wallace & Tiernan Products, Inc., Belle 9, New Jersey.*

Voltmeter

A new portable electrostatic voltm designed to meet the need for a h impedance high-voltage instrument in la ratory and industrial testing. Availabl five ratings—40-, 50-, 60-, 70-, and 75 rms—the instrument can be used to meas applied voltage during dielectric test, study electric phenomena, to determ peak voltage by the vacuum-tube meth to measure exceptionally high voltage w used with a voltage divider, and to termine peak voltage output of magne

The moving system consists of two fi electrodes between two small metal sph that revolve on a pivoted shaft on which mounted aluminum damping vanes, mirror, and a spring. The mirror reflect beam of light onto the scale, indicating position of the moving electrode.—*Gen Electric Co., Meter and Instrument Divisi West Lynn, Mass.*

Compressor Motor



Impact Tool

Timers

o new timers, Type TP and TS, de-
d especially for manufacturing and
ce establishments where use of per-
ent conduit or armored cable in stand-
witch-box cases is desired. The mecha-
is enclosed in a strong steel case having
manent black wrinkle finish. Featured
e design is a dual-disk face which
s ease of accurately setting up a desired
am, but does not indicate the time of
Type TP is designed primarily for bell
ng or signaling purposes; and Type TS
industrial control timer incorporating
ding circuit which closes the circuit on
first impulse and opens it on the
eeding impulse. It will automatically
on and turn off ovens, lights, fans, etc.
ontgomery Mfg. Co., 549 W. Washington
., Chicago 6, Ill.

Scaffolds

ew upright scaffolds made of heat-
ed lightweight aluminum alloy can be
mbled with speed and ease. A 7-ft single-
on unit can be erected in one minute by
man—a 45-ft multiple unit in 15 min.
e erected, the scaffolds can be rolled from
ion to position bridging obstacles. They
available in multiple-section units for
height; adjustable legs provide stability
desired working level. Sections fold flat
a simple lock-in feature eliminates all
nuts, bolts, and loose parts, and no
ches are required. A 4½ ft by 6 ft
dation area is standard, but optional
orts enlarge it to 10 ft by 10 ft. A
y-tread stairway permits the user to
nt the scaffold entirely within the
cture.—*Upright Scaffolds, 1013 Pardee*
Berkeley, California.

Rectifiers

Wider use of rectifier equipment has been made possible through the introduction of a new line of oil-immersed selenium rectifier stacks. Isolation from dampness and corrosive vapors, greater short-time overload due to increased thermal storage, protection from physical damage while in storage or during assembly, and large selection of ratings are features of the rectifiers. The oil acts as an effective cooling medium, and the container, which has a protective coating, resists the effects of moisture, fungus, salt air, and other corrosive vapors. Insulated solder lugs on one end of the rectifier provide easy, quick soldering connections.—*Appliance and Merchandise Dept., General Electric Co., Bridgeport 2, Conn.*

Expanding Anchor

A new expanding-type anchor made of high-strength malleable iron. The anchor has three long cone-slanted blades that extend deeply into undisturbed earth to provide maximum holding power. Tests have shown that the anchor will withstand a 46,000-lb pull. Installation is simple and effective. A three-, four- or six-inch hole (depending on size of anchor) is dug with auger to desired depth; a strand of light wire is placed around blades to hold them in place; and the anchor, with rod attached, is then dropped to bottom of the hole. A few blows with a spud on the anchor top breaks the wire and expands the blades, which advance outward and upward to full length in the undisturbed earth, quickly becoming locked into position ready for a full pull.—*Albion Malleable Iron Co., Albion, Michigan.*

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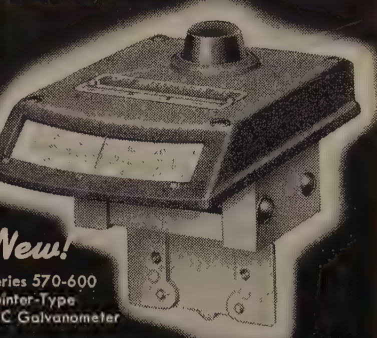

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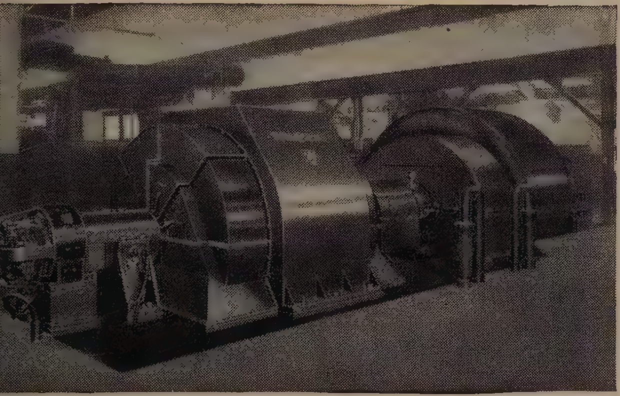

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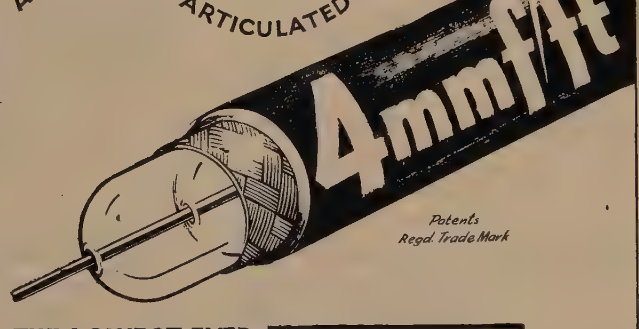

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C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C33	4.8	220	2.4	0.64
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BOOK REVIEWS

(Available books may be purchased through the GENERAL ELECTRIC REVIEW for domestic delivery; none sent on approval.)

FREQUENCY ANALYSIS, MODULATION AND NOISE (RADIO COMMUNICATION SERIES)

Stanford Goldman—McGraw-Hill Book Co., Inc., New York. 1948. 448 pp. $6.00.

As the title states, this book consists of three loosely related parts: frequency analysis, modulation, and noise. The author deals with these subjects, which are of steadily growing interest, in a very able manner.

The first part comprises a short but comprehensive treatment of the theory of Fourier series and the Fourier integral theory. Their practical application—the importance of which can hardly be overestimated, especially in television and pulse techniques—is most instructively treated.

Part 2 deals with the subject of modulation; in particular, amplitude and frequency modulation are considered, their relative merits compared, etc. It might be desirable in a new edition to add more details concerning the different types of pulse modulation; this field of increasing importance is only briefly covered.

The third and largest part of Goldman's book treats the various types of random noise. With this chapter the author undoubtedly fulfills a real need, since most of the information concerning this subject is scattered over a great variety of scientific periodicals and handbooks. Some remarks explaining how to cope with random noise, or at least some references to original papers of that kind, would have been helpful.

The author always amplifies the mathematical derivations by physical reasoning and shows, where possible, different approaches to the solution of the problems under consideration.

This highly useful book requires of the reader a good knowledge of calculus and general radio engineering. Its value is increased by the inclusion of tables (sine and cosine integral, integrals, trigonometric identities, Bessel functions) and a great number of exercises.

H. A. SAMULON

MATHEMATICS: OUR GREAT HERITAGE

Selected and edited by William L. Schaaf—Harper & Brothers, New York. 1948. 303 pp. $3.50.

Everyone knows that mathematics—the handmaiden of the sciences—is useful. Nearly everyone thinks that mathematics can only be understood by mathematicians. Many compare the mathematician to a designer of garments, "who is utterly oblivious of the creatures whom his garments may fit. To be sure, his art originated in the necessity for clothing such creatures, but this was long ago; to this day a shape will occasionally appear which will fit into the garment as if the garment had been made for it. Then there is no end of surprise and of delight!"

This little book contains a charming series of essays about mathematics, telling in simple terms of its art, its nature, its history, and its processes. The reader is enticed on and on, until he ends by wanting to become a mathematician himself.

Mathematics is all-pervasive in modern life. Behind any measuring device, however simple, "behind any scientific instrument, there is the master instrument, arithmetic, without which the special device can neither be used nor even conceived."

At the same time, mathematics is the agent that is unlocking the secrets of the galaxies and the finite universe, the atom and the sources of energy on which all life depends. Of mathematics it may be said, as of Shakespeare's Cleopatra, "Age cannot wither her, nor custom stale her infinite variety."

Seriously, any one who tries to draw conclusions from his observations, to make a new design, or to predict an event, must apply mathematics. All such will gain enjoyment and broader perspective, and all others will gain increased appreciation of science, by reading these essays.

P. L. ALGER

THE STRANGE STORY OF THE QUANTUM

Banesh Hoffman—Harper and Brothers, New York. 1947. 239 pp. $3.00.

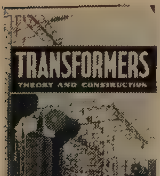
This is not just another popular book on the atomic bomb. It is not another elaboration of the Smythe report written by journalists with a flair for science to enlighten the layman with a curiosity for things scientific. It does not describe the cyclotron, and General Groves does not appear even in the Index.

The book tells about things that are completely unknown to the average author of those types of books; it talks of things that are known only to those who themselves were participant in the creation of the atomic age. It relates in the language of the scientifically untrained layman the involved, exciting, and often chaotic quest by scientists to understand the structure of the
atom, a search that finally culminated in t
construction of an edifice just as complicat
as the atom itself, namely, quantum m
chanics. The story of the quantum is told
the manner of an unfolding drama, with
central theme focused upon the conflict
tween two rivals, the particle and the wa
each attempting to monopolize and rule t
world of both radiation and matter.

In the Prologue an almost forgott
"prehistoric" conflict concerning the nat
of light is reviewed in which the corpuscul
theory of Newton battles with the undul
tory theory of Huygens. This prematu
local rebellion ends in the complete rout
the particle theory of light, and when t
curtain falls the physicists worry on
about the value of the last significant figu
beyond the decimal point.

The first act opens with a new rebelli
of the particle against the wave, again
the field of light. The skirmish starts wi
Planck's apologetic introduction of the co
cept of the quantum to explain the blac
body radiation, and is followed by a mo
energetic bombardment with the phot
of Einstein, to clarify the photoelectr
effect. The battle reaches its culminati
when Bohr successfully explains the Balm
series of atomic spectra with the aid
quantized orbits. This is the golden age
the "old" quantum theory.

The second act starts with a counte
attack, the wave now invading the land
the particle itself. De Broglie ascribes wav
length and frequency to a particle, and h
idea is corroborated a few years lat
by the electron-diffraction experiments
Davisson and Germer. Based upon th
tactics of an earlier "prehistoric" counte
attack of the wave by Hamilton, a decisiv
victory is achieved by Schrödinger, whos
wave-equation successfully explains atom
spectra without the artificial assumptio
of Bohr. In the meantime the partic
organizes its defenses in the form of Heise
berg matrices, a type of mathematic
fortress that few physicists could scal
The act closes with the reconciliation of th
wave and particle points of view by Heise
berg, Dirac, and Bohr, in terms of thos
extraordinary ideas of space, time, matte
and causality that are now the accepte
basis of atomic physics. The Epilogue giv
a glimpse into the quantum theory of th
nucleus of an atom, explaining thin
which are not to be found at all in the mo
conventional popularized books on atom
energy.



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hough the book is intended for the
cientific layman, the engineer who plans
udy the more technical though ele-
ary texts of Dushman or Rojansky on
tum mechanics will find it a welcome
duction to the new physics. It is sur-
ng how aptly the author selects every-
nalogues to explain abstract concepts,
as a laundry list and a road-map
ge table for a matrix, and the uncer-
position of a submerged submarine for
lectron-wave. (He is not afraid to
ion even spinors.) The educated lay-
as well as students and teachers of
tum mechanics will find in the book a
of simple illustrations of abstract
nings, clear descriptions of a host of
doxes, and, above all, an eloquent style
a gentle humor.

GABRIEL KRON

CTRICITY AND MAGNETISM
Nelkon—Longmans, Green & Co., Inc.,
York; Edward Arnold & Co., London.
439 pp. $2.75.

is text-book, dealing primarily with the
ical principles of electricity and mag-
m, may be classified as a very good
nd- and possibly first-year text in college
neering and physics. It was the author's
t not to provide a detailed handbook
rather to present the concepts of elec-
y and its associated subjects in such a
ner that advanced study in this field
t be undertaken.

ne subject matter is presented in a clear
logical order which generally does not
ire a knowledge of calculus for complete
rstanding. The book, in addition to a
ough treatment of the fundamentals,
des many chapters on material gen-
y omitted from such a text. Among
are Thermoelectricity, Elementary
Theory, Radioactivity, X-rays, and
nentary Quantum Theory.

particularly valuable asset of the book
n its many sample problems following
chapter, which serve as illustrations of
physical concepts and provide exercise in
use of electrical units and symbols.
e exercises are further improved by the
sion of answers, so that any problems
ked can be verified.

ne book is recommended as a reference
practicing electrical engineers and as a
for those interested in learning the
amentals of electricity.

E. H. FREIBURGHOUSE, JR.

LYTIC THEORY OF CONTINUED FRAC-
ONS
S. Wall—D. Van Nostrand Co., Inc.,
York. 1948. 448 pp. $6.50

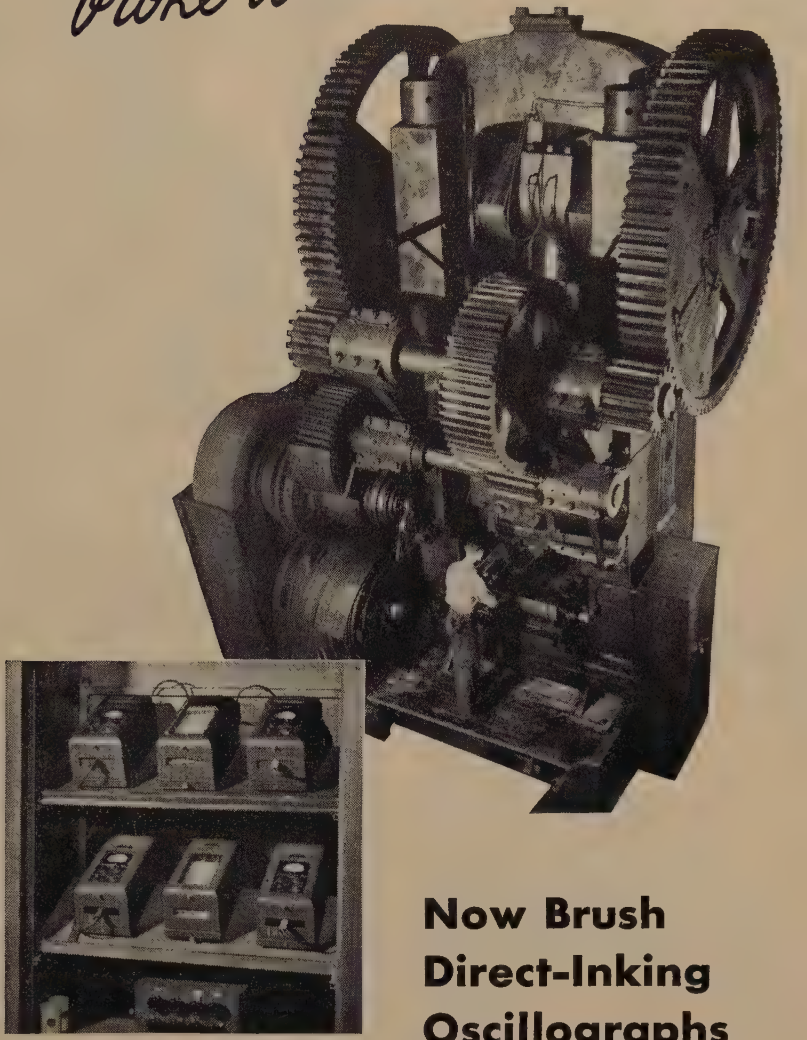
nis is the first of a proposed series of
nced texts and reference books in pure
applied mathematics presented by the
ishers. It presumes that the reader has
a first course in function theory, includ-
a knowledge of the elementary proper-
of linear fractional transformations in
complex plane. It is not a complete
tise on continued fractions, as it covers
an analytic theory and does not in-
e the arithmetic theory.

ne book is written primarily for mathe-
cians and not for engineers, but may be
terest to some engineers because of the
ters on convergence of series and be-
e continued fractions have a place in
it theory.

CHARLES CONCORDIA

RECTION: In the review of *The Manufac-
of Glass* by Dr. Louis Navias in the
mber issue, p. 62, the word "flues"
the end of the paragraph beginning
the words Section II should have been
es."

Every time the crankshaft broke it cost $15,000...



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weight Control—The advantages of rate automatic bit-weight control are ized, followed by a detailed explanation ow the control works. Schematic dia- ns of the mechanical and electrical lay- are included. GEA-5055. Four pages.—*ral Electric Company, Apparatus Dept., nectady 5, N. Y.*

zing—An instruction bulletin aided by erous small sketches with corresponding -by-step procedure for brazing fittings ipe and tubing with Easy-Flo and Sil- Bulletin 17. Four pages.—*Handy and man, 82 Fulton St., New York 7, N. Y.*

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Plugs—Photographic illustrations, dimensional drawings, exploded views, application pictures, and technical data on the battery connector line used largely on aircraft batteries and starting equipment, oilfield and stationary engine-starting equipment, and general industrial starting equipment. Bulletin No. 6B-648. Twenty-four pages.—*Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.*

Pump and Heater Sets—In addition to a description of the equipment, this bulletin explains some of the various elements and factors to be considered in the design of equipment for individual plant requirements. Bulletin 150. Four pages.—*Peabody Engineering Corp., 580 Fifth Ave., New York 19, N. Y.*

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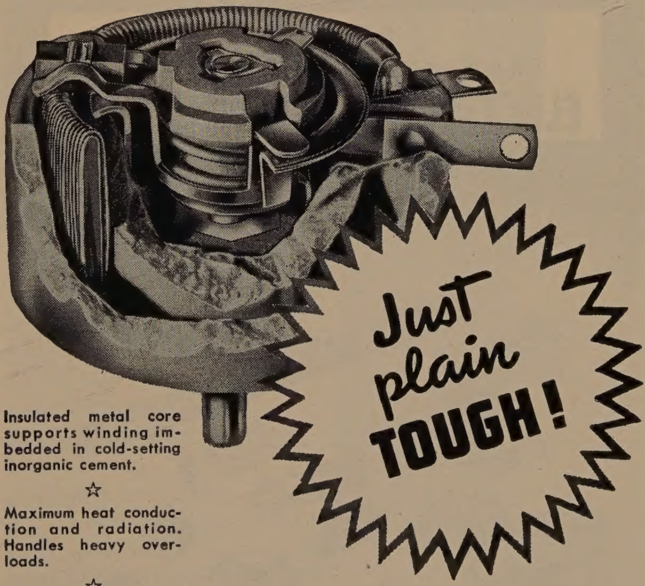

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Wind-tunnel Testing Problems in Superaerodynamics, by Hsue-Shen Tsien.
Jour. Aero. Sci., Oct. 1948; v. 15 pp. 573-580.

The wind tunnel as used in the solution of problems in the aerodynamics of rarefied gases.

ALLOYS

Age-hardening Nickel Alloys, by Frederick C. Ochsner.
Prod. Engng., Oct. 1948; v. 19, pp. 126-128.

Properties and uses for a new group of nickel alloys having controlled elastic properties or controlled expansion characteristics. Pertains to the Ni-Span series of alloys.

Special Magnetic Alloys and Applications, by G. W. Elmen and E. A. Gaugler.
Elec. Engng., Sept. 1948; v. 67, pp. 843-845.

How superior operating characteristics may be obtained in contact rectifiers and magnetic amplifiers by the use of alloys having rectangular hysteresis loops.

BEARINGS

Metallurgical Aspects of Ball-bearing Steels, by A. S. Jameson.
Iron Age, Sept. 2, 1948; v. 162, pp. 72-79.

Chemical analysis and its influence on hardenability; nonmetallic inclusions and carbide segregation and their effects on bearing life, are among the concepts discussed in this first part of a three-part article.

Apparatus for Measuring the Static Frictional Torques of Instrument Jewels, by W. H. Pearse.
Jour. Sci. Instr., Oct. 1948; v. 25 pp. 344-346.

Equipment which can be used to obtain a measure of the surface quality of synthetic sapphire 'V' jewels and hence enable their performance as jewel bearings for precision indicating instruments to be expressed quantitatively.

BRAZING

Furnace-brazed Assemblies Replace One-piece Units, by H. M. Webber.
Am. Mach., Sept. 9, 1948; v. 92, pp. 92-96.

Typical jobs at American Bosch exemplifying good practice that will guide others in similar cost-reducing applications.

Welding and Low-temperature Brazing of Air-conditioning and Refrigerator Parts, by Ward Swarthout.
Steel Processing, Aug. 1948; v. 34, pp. 416-419.

CASTINGS

Aluminum-alloy Castings, by Floyd A. Lewis.
Foundry, Sept. 1948; v. 76 pp. 90-93, 212, etc.

Recommended practices in cleaning and finishing aluminum-alloy castings are described in this tenth of a series of articles.

ELECTRON OPTICS

Electron Lenses of Hyperbolic Fiel Structure, by Reinhold Rüdenberg.
Franklin Inst. Jour., Oct. 1948; v. 246, pp 311-339.

Their theory, and data for use in thei calculation.

FLUID FLOW

Diabatic Flow of a Compressible Fluid by Bruce L. Hicks.
Quar. App. Math., Oct. 1948; v. 6, pp 221-237.

A mathematical study of the phenomena of combustion aerodynamics.

Pressure Loss for Liquid Flow in Pipes Viscosity and Pipe Roughness Corrections, by R. D. Madison and W. R. Elliot.
Chem. Engng. Prog., Sept. 1948; v. 44, pp. 703-706.

FURNACES

Determining Furnace Heat Transfer by Gas Temperature Measurement, by H. F. Mullikin.
Power Gen., Aug. 1948; v. 52, pp. 68-71, 116, etc.

Rapid Billet Heating With Gas, by L. J. Stanbery and J. M. Brennan.
Iron Age, Aug. 26, 1948; v. 162, pp. 82-85.

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ENTHALPY-ENTROPY DIAGRAM (COMBUS-ION GAS—KEROSENE), by Henrich Rein-lorf.
ech. Data Digest, Sept. 1, 1948; v. 13, pp. 1-17.
A diagram for simplifying the calculation of power output of turbojet installations.

XPERIMENTAL STUDY OF COOLING BY NJECTION OF A FLUID THROUGH A POROUS MATERIAL, by Pol Duwez and H. L. Wheeler, Jr.
our. Aero. Sci., Sept. 1948; v. 15, pp. 09-521.
A method of coping with the high rates of heat transfer encountered in the field of jet propulsion consists of making the parts to be cooled of a porous material and forcing the cooling fluid through the pores in a direction opposite to that of the heat flow. The method is called sweat-cooling.

MEASURING INSTRUMENTS

ELECTRICAL INSTRUMENT CALIBRATING FOR INDUSTRY, by William L. Kinsell.
Instruments, Sept. 1948; v. 21, pp. 830-834.

NUCLEAR DISINTEGRATION SCHEMES AND THE COINCIDENCE METHOD, by C. E. Mandeville and M. V. Scherb.
Nucleonics, Oct. 1948; v. 3, pp. 2-12.
Nature and geometry of counters for measuring beta-gamma, gamma-gamma, and beta-beta coincidences are described, together with methods for obtaining data for decay schemes.

METALLOGRAPHY

APPLIED X-RAY METALLOGRAPHY, by Norman P. Goss.
Steel, Sept. 5, 1948; v. 123, pp. 114, 117, 132, 134, etc.
Arrangement of atoms in a crystal on the space lattice, as well as two types of lattice systems, are explained.

KAPPA EUTECTOID TRANSFORMATION IN THE COPPER-SILICON SYSTEM, by Walter R. Hibbard, Jr. and others.
Metals Tech., Sept. 1948; v. 15, Tech. Pub. no. 2441, 9pp.

RADIO ENGINEERING

DIRECT-READING INSTRUMENT FOR THE MEASUREMENT OF NOISE FACTOR, AND ITS APPLICATION TO THE TESTING OF MICRO-WAVE MIXER CRYSTALS, by L. A. G. Dresel and others.
Jour. Sci. Instr., Sept. 1948; v. 25, pp. 295-298.
A method is outlined by which the noise factor of a receiver can be recorded directly, as a reading on a suitably calibrated meter.

NEW THEATER LOUDSPEAKER SYSTEM, by H. F. Hopkins and C. R. Keith.
Soc. Motion Pict. Engrs. Jour., Oct. 1948; v. 51, pp. 385-398.
Employs sectoral high-frequency horns and a cross-over frequency of 800 cycles. Improvement is obtained in uniformity of distribution and reduction of size and weight.

SPECTRA OF QUANTIZED SIGNALS, by W. R. Bennett.
Bell System Tech. Jour., July, 1948; v. 27, pp. 446-472.
Mathematical treatment of a system of communication which consists in quantizing the magnitude of speech signals and in transmitting a wave constructed of quantized values. The system is applicable to multiplex telegraphy and to pulse code modulation.

SPLINES

STRAIGHT-SIDED SPLINES, by J. B. Armitage.
Mech. Engng., Sept. 1948; v. 70, pp. 738-742.
Proposes a set of tolerances and allowances for both the male and female members for five classes of fit.

SUPERSONIC SPEEDS

MAN GIRDS FOR SUPERSONIC ROLE.
Aviation Week, Sept. 27, 1948; v. 49, pp. 21-24.
Extensive research aims to insure pilot efficiency and survival in the hazardous realm of high speeds.

TRANSDUCERS

VARIABLE-RESISTANCE SPRING TRANSDUCER.
Nat. Bur. Stds. Tech. News Bul., Oct. 1948; v. 32, p. 122.
A highly sensitive mechano-electrical transducer, which transforms slight displacements into large changes of resistance, current, or voltage, is being developed by the Bureau. A brief description.

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THE IGNITION TRANSFORMER; ITS CONTRIBUTIONS TO SATISFACTORY OILBURNER PERFORMANCE, by J. A. Uttal.
Fueloil & Oil Heat, Oct. 1948; v. 7, pp. 58-60.
Their construction and uses are here explained.

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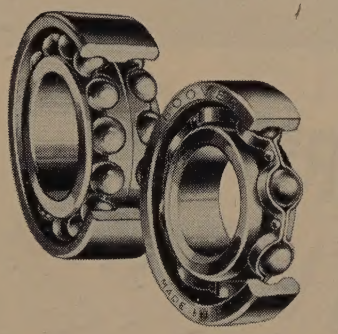

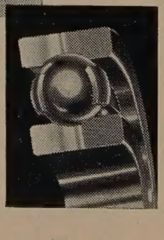

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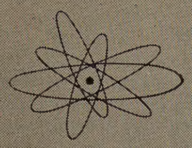

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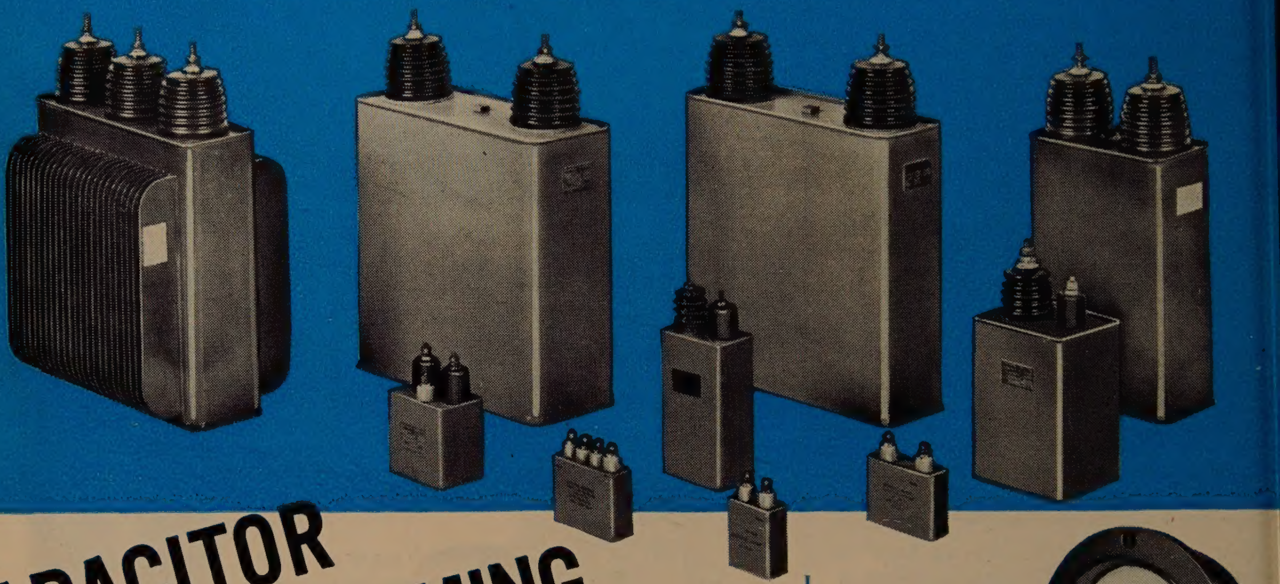

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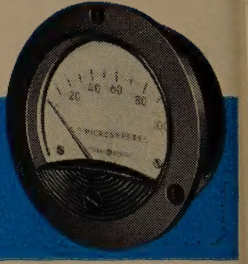

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